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Balancing Innovation and Regulation: Cybersecurity Laws and Sustainable Digital Commercial Transactions in India

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The digital economy has revolutionized the way business is done in India at a rapid pace. Business-to-consumer interactions include e-commerce, digital payments, app-based services, online contracts and financial ecosystems. This has resulted in an improvement in convenience, speed and market access but also an increase in the risk of identity theft, phishing, cyber fraud, data breaches, payment manipulation and unauthorised access to private and business data. So, cybersecurity is now no longer merely a technical issue. This legal, corporate and governance issue is closely linked to trust in the digital economy. The paper deals with the legislative framework of India in the context of Cyber security and online business transactions. It adopts a doctrinal secondary-study method. All of which include The Information Technology Act, 2000, Information Technology (Amendment) Act, 2008, Payment and Settlement Systems Act, 2007, CERT-In Directions, 2022, Digital Personal Data Protection Act, 2023 and relevant RBI rules. The article states that for online commerce to work, innovation and regulation must be balanced. Too much regulation stunts growth, while too little regulation leaves firms and consumers at the mercy of major security issues. The article highlights the institutional and legal loopholes, the increasing role of data governance and incident reporting, and concludes that India needs a more proactive, coordinated and enforcement-driven framework to facilitate safe and sustainable digital business transactions.

Key Words: Digital Personal Data Protection Act, Information Technology Act, Cybersecurity Laws, Digital Commercial Transactions, Sustainable Digital Economy, E-Commerce Law, Cyber Frauds, FinTech Regulation, India

Introduction

The economic landscape of India has experienced a lot of upheaval in the last ten years. Transactions that once depended on paper records, physical presence and traditional banking techniques are giving way to digital, real-time and platform-based transactions. Many customers utilize mobile apps for shopping, digital payments, utility bills, subscriptions, banking, and contracts for services. Businesses engage with customers and run effectively through digital storefronts, online records, cloud storage, payment gateways and data analytics. That has meant lower transaction costs, higher speeds and better commercial access for both huge enterprises and small firms.

India's digital economy has risen on the back of significant infrastructural and policy developments. The growth of smartphones, cheap internet, the popularity of UPI and government programs such as Digital India have enabled a commercial ecosystem where digital transactions are no longer an option. They are part of the economy in everyday life.

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This is especially true in India where digital tools have been helpful in narrowing gaps in access and engagement. But digital systems that enable the growth of business also introduce new threats. Cyber criminals use several methods such as weak passwords, false payment URLs, cloned merchant pages, phishing emails, phony QR codes, malware and social engineering techniques. Businesses are vulnerable to ransomware, currency diversion, database breaches and internal security weaknesses. Besides the financial loss, these occurrences erode customer trust and lead to misunderstanding in the digital economy. The first legislative framework for India was the Information Technology Act of 2000 which gave legal legitimacy to digital signatures and electronic documents. This was an important basis to online contracts and e-commerce. Information Technology (Amendment) Act, 2008: Laws on identity theft, personation fraud, data carelessness and intermediary responsibility added. But the present digital economy is much more complex than the system these rules were initially designed for. Today's corporate systems are transnational, data-driven and depend significantly on digital trust. That's why regulations for cybersecurity are more important now." It's about more than just punishing hackers. Also vital are trust, good data procedures, company continuity, and continued digital commerce. A deal is legally sound but dangerous the effect is commercial instability. In addition to fostering inventiveness, the law must encourage accountability, security and resilience.

Literature Review

The first work done in the field of Indian Cyber Law was related to the Information Technology Act, 2000 and its importance for the validation of digital signatures, online contracts and electronic documents. These studies have accepted the IT Act as the legal basis of Indian e-commerce. Clauses relating to identity theft, data negligence, confidentiality breaches and intermediary liability would have been the subject of later articles, particularly following the 2008 revision. Most academics agree these improvements have enhanced the judicial system. However, many point out the law is still mostly offense focused and reactive.

Another stream of literature comes from research in trade, finance and fintech. These initiatives are related to online fraud protection, wallet systems, payment gateways, UPI growth and digital payments. They stress that robust legal protections, payment security rules and fast grievance redressal are as crucial to digital commerce as technological efficiency. In this regard, the role of the RBI and the Payment and Settlement Systems Act, 2007 is often stressed. More recent literature has been focused on data governance and privacy. Given the higher commercial value of personal data, academics routinely discuss cybersecurity in conjunction with authorization, data reduction, breach notification, and platform accountability. The Digital Personal Data Protection Act 2023 is being considered as a big shift in the digital governance landscape of India as it places the data duties squarely in the commercial domain. The CERT-In Directions, 2022 are seen as a major compliance milestone by policy and industry analysts as they underline the importance of reporting requirements, incident preparedness and cyber hygiene. But most of the material available now is about data protection, digital payments, cyber law and e-commerce laws independently. However, there is a lack of integrated research looking at them as part of a single legal framework affecting the long-term viability of digital commercial activities. This paper addresses that gap.

Significance and Scope of the Study

The importance of this study is that it addresses a new challenge at the crossroads of management, policy, law and commerce. Digital commerce plays an important role in India's economy, but if its platforms are to be sustainable, they need to be trustworthy and safe. The paper goes further than a mere criminal law approach, treating cybersecurity as a commercial and governance issue and demonstrating that legal certainty, data protection, breach response, and platform accountability are critical components of the future digital economy. The study will be of interest to researchers, legislators, fintech companies, e-commerce platforms, lawyers and experts in consumer protection. The analysis is limited to Indian legislation relating to digital commercial transactions. This includes: platform-based transactions, digital payments, online contracts, e-commerce and data-related tasks that impact business systems. This is not military cyberwarfare, technical cybersecurity engineering, or large-scale global comparative study. It is still theory, regulation and policy driven.

Objectives of the study

- 1.To study the legal aspects of cyber security in online commercial transactions in India.
 - 2.To examine the existing legal and regulatory framework on cyberthreats in the field of online commerce.
 - 3.To compare current and old regulations regarding internet business transactions.
 - 4.To review the role of Information Technology Act, 2000, IT Amendment Act, 2008, Payment and Settlement Systems Act, 2007, CERT-In Directions, 2022 and Digital Personal Data Protection Act, 2023.
 - 5.To identify institutional, legal and regulatory weaknesses affecting the viability of digital commerce.
- Offer practical solutions that strike a balance between cybersecurity compliance, innovation and consumer safety.

Research Methodology

The present study is based on a doctrinal and analytical research methodology, exclusively on secondary sources. The paper deals with the legal development, adequacy and comparative value of the regulations on digital



commercial transactions, hence secondary study is apt and academically justifiable. The research is qualitative and does not involve field surveys or interviews.

Key legal sources include the Information Technology Act, 2000, the Information Technology (Amendment) Act, 2008, the Payment and Settlement Systems Act, 2007, the CERT-In Directions, 2022, the Digital Personal Data Protection Act, 2023 and the RBI guidelines on cybersecurity and security of digital payments. These materials form the legal and regulatory basis for the analysis.

Secondary sources include books on cyber law and e-commerce law, research articles, conference papers, policy reports, legal commentary and publications of institutions. The process involves statutory interpretation, comparative legal analysis and critical policy review. The report contrasts the former architecture that enabled digital transactions with the latter architecture that is increasingly governing data, compliance and cyber accountability.

Research Gap

However, there is a growing literature on cyber-crime, digital payments, privacy and e-commerce regulation, but an integrated study on cyber security laws and sustainable digital commercial transactions in India is still limited. Many studies deal on technical threats or individual statutes. Others separately debate consumer protection, financial fraud and privacy, ignoring the interrelation of these concerns in real business settings. There is also no comparative work on the move away from a cyber regulatory paradigm centred on the IT Act to a wider approach that now incorporates data protection duties, incident reporting and sector-specific compliance. This essay seeks to fill this gap by conceptualizing cybersecurity legislation as an enabler of sustainability of digital trade, rather than merely an enforcement mechanism after the fact.

Expected Outcome

- Better understanding of the impact of cybersecurity law on digital commercial trust and business continuity.
- Recognized the strengths and weaknesses of the existing Indian legislative framework on digital commercial transactions.
- A look at how past laws permitted electronic transactions and how newer laws more heavily govern data, compliance and breach response.
- Recognizing that continued digital commerce depends on legal certainty, consumer trust, cyber resilience, and institutional enforcement.
- Practical suggestions for future legislative and policy reform in India

Comparative Analysis of Old and New Laws Related to Digital Commercial Transactions in India

The main contribution of this study is to comparatively analyse the Indian legal methods towards digital business transactions, ancient vs new. The old approach was primarily for digital transactions and some cyber offenses. The modern paradigm is increasingly about data governance, accountability, reporting obligations and operational compliance. This is a paradigm shift in legal thinking, from validating digital trade to securing and sustaining digital commerce. The Information Technology Act, 2000 was a path breaking Act since it extended legal status to electronic records and digital signatures. This was important for the development of online contracts and e-commerce. The Information Technology (Amendment) Act, 2008, added regulations relating to identity theft, cheating by personation, data negligence, breach of confidentiality and intermediary liability, further strengthening the framework. These additions improved the legislation, but the structure remained fundamentally reactive. The Payment and Settlement Systems Act, 2007 became more significant with the advent of digital payments. It helped Reserve Bank of India to regulate payment systems and created institutional discipline in payment techniques which are key to digital commerce today. The CERT-In Directions, 2022 brought in stricter standards for reporting of cyber events, time synchronisation and retention of logs. This was indicative of progressing towards essential cyber hygiene and operational readiness.

The Digital Personal Data Protection Act, 2023 represents a larger transformation. This is a recognition that internet commerce is data driven. In the marketplace consumer IDs, contact information, payment and payment history are all crucial and sensitive in terms of the law. The DPDP Act thus puts data stewardship at the center of business regulation. So, to sum up, the old framework enabled digital commerce and the new framework is starting to regulate and secure it.

Findings

- The legal environment in India has evolved from recognition of transactions to regulation of the entire digital ecosystem.
- The Information Technology Act, 2000 nevertheless remains a basic piece of legislation but cannot be considered as a complete foundation for digital commercial issues of today.
- The 2008 change improved the law, but many of its provisions are still reactive rather than proactive.
- The Payment and Settlement Systems Act, 2007 and RBI instructions are of paramount importance for the security of digital payment ecosystems.



- The CERT-In Directions, 2022 has developed a compliance culture with a higher focus on incident reporting and operational readiness.
- The Digital Personal Data Protection Act, 2023 highlights the major change in the direction of accountability in data-driven business environments.
- The existing system is still fragmented, with overlapping institutional responsibilities and uneven awareness among enterprises, particularly smaller ones.
- Sustainable digital commerce is built on trust, and trust is anchored in security, lawful data practices, enforceability, and effective remedies.

Recommendations and Suggestions

- Amend and modernize the Information Technology Act, 2000 to better fit with platform commerce, AI assisted fraud, cloud-based business systems and evolving commercial cyber threats.
- Better harmonization of IT Act, DPDP Act, CERT-In Directions and RBI standards to reduce redundancy, ambiguity and uncertainty of compliance.
- Develop clearer responsibility regulations for e-commerce platforms, payment intermediaries, data fiduciaries and merchants in the event of cyber negligence or data misuse.
- Build cyber enforcement capacity through specialized training, digital forensics infrastructure and sector-specific commercial cybercrime investigative groups.
- Develop realistic compliance solutions for SMEs, startups, payment aggregators and small digital merchants so that cybersecurity does not become an unmanageable expense for new businesses
- View cybersecurity as a board level governance issue for commercial businesses, not just a technical responsibility.
- Increase cyber awareness among consumers and businesses, especially about phishing, payment schemes, counterfeit links, QR-code fraud and unsafe data-sharing.
- Promote a long-term policy vision for a more coordinated framework for digital commercial transactions including e-contracts, data protection, payment security, cyber incident obligations and consumer redress.

Comparative Table: Digital Commercial Transactions, Existing Legal Position, and Future Reforms

Digital Commercial Transaction	Existing / Older Legal Position	What Can Be Done in Future
Online Contracts and E-Agreements	IT Act, 2000 recognizes electronic records and digital signatures, enabling online contracts and enforceability.	Update legal standards for click-wrap, browse-wrap, platform terms, and AI-assisted contracting with clearer consumer consent rules.
E-Commerce Marketplace Transactions	IT Act, Consumer Protection framework, and intermediary principles indirectly govern online marketplace conduct.	Create clearer platform accountability standards for seller verification, fake listings, refund disputes, and cyber fraud response.
Digital Payments (UPI, Wallets, Gateways)	Payment and Settlement Systems Act, 2007 and RBI guidelines regulate payment systems and transaction security.	Introduce stronger uniform cyber-risk allocation, faster dispute resolution, and clearer liability rules for merchants, aggregators, and payment intermediaries.
Data Handling in Commercial Transactions	Section 43A of IT Act and SPDI Rules offered limited and fragmented protection for sensitive data.	Fully operationalize DPDP Act with business-friendly compliance templates, breach protocols, and sector-specific data governance standards.
Cyber Fraud and Identity Theft	IT Amendment Act, 2008 added provisions on identity theft, cheating by personation, and cyber offences.	Strengthen enforcement, digital forensics, and sector-specific cybercrime response units for commercial frauds and payment scams.
Incident Reporting and Cyber Preparedness	Older framework was largely reactive and did not impose a broad modern compliance culture across businesses.	Expand practical implementation of CERT-In reporting obligations, cyber drills, log retention discipline, and board-level cyber governance.
Consumer Trust and Digital Sustainability	Older laws enabled digital transactions but did not explicitly connect cybersecurity with sustainability and trust.	Develop an integrated digital commercial transactions framework linking cyber resilience, privacy, grievance redress, and sustainable digital business practices.



Conclusion

India's digital commercial economy has entered a new era of legal evolution. The prior legislative framework specifically the Information Technology Act, 2000 has been a cornerstone in legitimizing electronic transactions and enabling the expansion of e-commerce. The 2008 amendment also defined new cyber damages. But the digital economy of today is far more complex than the one in which those rules were written.

Modern digital commerce is not just about e-contracts. It's about platform ecosystems, digital payments, customer data, merchant networks and real-time settlement solutions. In a setting like this, cybersecurity law can't be a secondary concern. It has become a vital part of the sustainability of digital commerce itself. Without cybersecurity protection, it cannot stay Commercially viable a legally authorized transaction.

The current legislative developments in India are a welcome move. The CERT-In Directions, 2022 and the Digital Personal Data Protection Act, 2023 are a move away from the legacy, transaction-validating system to a more mature, compliance-based and governance-oriented framework. But there are weaknesses in the system such as fragmentation, enforcement challenges, insufficient awareness and inconsistent compliance skills. And the greater lesson is clear: the future of digital commerce in India is bound not only to innovation, but to regulated innovation. The law must foster progress, but it must protect responsibility, security and confidence.

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This research paper provides a critical review of India's role within the South Asian Association for Regional Cooperation (SAARC). It analyses India's position as a geopolitical centrepiece in South Asia, its 'Neighbourhood First' policy, and the underlying reasons for the current stagnation or inactivity of SAARC. Furthermore, the paper sheds light on the impact of China's increasing intervention in the region and the emergence of alternative organizations such as BIMSTEC, evaluating their consequences on the future of SAARC.

Keywords: South Asian Association for Regional Cooperation, India's Foreign Policy, Regional Cooperation, South Asian Geopolitics, Strategic Relations, Regional Security, Economic Integration, Cross-Border Relations, Diplomatic Challenges, Political Stability, India-Pakistan Relations, Regional Connectivity, International Relations, South Asian Development, Geo-political Transition, Multilateralism, Strategic Diplomacy, Regional Trade, Security Cooperation, Emerging Global Order.

Introduction

South Asia is not merely a geographical region; it is the world's most populous, culturally rich, and geopolitically sensitive territory. While occupying only 3% of the world's land area, it is home to 21% of the global population. To weave this diverse region into a single thread of economic progress and peace, the 'South Asian Association for Regional Cooperation' (SAARC) was established on December 8, 1985, in Dhaka, Bangladesh. The vision behind SAARC was to transform South Asia into an integrated economic powerhouse, similar to the European Union (EU). Within this vision, India emerged as a 'natural leader' and a 'geographical pivot.' Due to its vast size, growing economic prowess, and democratic values, India's role in SAARC has been more than just a member—it has been the 'backbone' of the organisation. However, a look at the history of the last four decades reveals that SAARC's journey has been defined more by challenges than successes. On one hand, there are endless opportunities for economic cooperation; on the other, cross-border terrorism, border disputes, and mutual distrust have pushed the organisation's relevance to a critical crossroads. In particular, India's 'Neighbourhood First' policy adopted after 2014 and the rise of alternatives like BIMSTEC due to SAARC's recent inactivity have brought significant shifts in South Asian politics. This research paper provides an in-depth exploration of India's historical role within SAARC, its contributions to economic and strategic sectors, and the geopolitical challenges posed by countries like Pakistan. Furthermore, it analyses the necessity for India to revive SAARC in the changing global landscape and explores potential pathways for doing so.



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Scope of the Study

The scope of this research paper is limited to the following components:

- **Geographical Scope:** This paper primarily studies the geopolitical developments within the borders of the eight SAARC member nations (India, Pakistan, Bangladesh, Sri Lanka, Nepal, Bhutan, Maldives, and Afghanistan).
- **Temporal Scope:** It covers the changing global and regional equations from the establishment of SAARC in 1985 to the year 2026.
- **Depth of Subject:** The study examines not only diplomatic relations but also economic trade (SAFTA), security issues, terrorism, and China's increasing intervention in South Asia.
- **Policy Scope:** This paper highlights India's 'Neighbourhood First' policy and the emergence of alternative groups (BIMSTEC) resulting from SAARC's inactivity.
- **Significance of the Study**
- Studying this subject is of vital importance for the following reasons:
- **For Regional Peace:** South Asia is globally sensitive due to the ongoing tensions between two nuclear-armed neighbours (India and Pakistan). Understanding the impact of this friction on SAARC is essential for regional stability and peace.
- **Perspective on Economic Development:** Home to 21% of the world's population, this region possesses vast human resources. This paper highlights how achieving economic integration through SAARC can transform the region into a global trade hub.
- **Analysis of India's Leadership:** This study clarifies how India's role as the 'heartland' of South Asia is not limited to a single nation but is decisive for the stability of the entire region.
- **Addressing the China Challenge:** Analysing China's growing influence in India's 'backyard' is a necessity in the current era, as it poses significant risks to both India's security and the long-term existence of SAARC.

Research Objectives

1. **To Clarify India's Role:** To analyse the leadership and role played by India in shaping SAARC since its inception.
2. **To Study Economic Contributions:** To evaluate India's economic efforts aimed at increasing trade among South Asian nations.
3. **To Identify Key Challenges:** To examine obstacles such as the India-Pakistan conflict, terrorism, and mutual distrust among neighbouring countries.
4. **To Analyse Chinese Intervention:** To study the challenges posed to India's policies by the growing Chinese influence in South Asia.
5. **To Examine Alternatives and the Future:** To explore the rising importance of alternative organisations like BIMSTEC due to SAARC's inactivity and to identify future opportunities for SAARC.

India's Centrality in SAARC

In the political geography of South Asia, India's position is not merely 'important'—it is indispensable. Within the SAARC framework, India is a powerhouse that is larger than the combined strength of all other seven members. This central role can be analysed across three primary dimensions:

Geographic Indispensability: The Backbone of SAARC India's geography is both the greatest boon and the most significant challenge for the organization. **Central Location:** Geographically, India is the heart of SAARC. For Pakistan to connect with the Maldives, or Nepal with Sri Lanka, traversing Indian territory or maritime zones is practically unavoidable. **Shared Borders:** India is the only SAARC nation that shares borders (land or maritime) with every other member state, including Afghanistan. Conversely, most other member nations do not share direct land borders with one another. **Transit Hub:** For landlocked nations like Nepal and Bhutan, the Indian mainland serves as the primary gateway to global trade. This positioning makes India the 'Natural Gateway' of South Asia. **Economic Dominance:** The Engine of South Asia India stands like a massive tree in the South Asian economic landscape, under whose shade other economies find room to grow. **Share in GDP:** India alone accounts for over 80% of the total Gross Domestic Product (GDP) of South Asia. Its economy is several times larger than the combined GDP of the remaining seven nations.



Market Availability: With a population of 1.4 billion, India is the largest consumer market for SAARC nations. Whether it is Bangladesh's textiles or Nepal's hydroelectric power, large-scale trade is nearly impossible without Indian participation. **Investment and Aid:** India is the largest contributor to infrastructure development in neighbouring countries (e.g., the Parliament building in Afghanistan and railway projects in Sri Lanka).

Cultural Heritage: The Unbroken Threads

India's strength lies not just in geography and finance, but in its profound Soft Power.

Cultural Links: India is the birthplace of several major religions (Hinduism, Buddhism, Sikhism, Jainism) and has maintained deep historical ties with Islam and Christianity for centuries.

Linguistic Unity: The threads of languages and cultures—such as Bengali in Bangladesh, Nepali in Nepal, Urdu in Pakistan, and Tamil in Sri Lanka—are intricately woven into India's social fabric.

People-to-People Connect: Despite political boundaries, the people of South Asia remain connected through shared traditions ("Roti-Beti" relations), cinema, music, and a mutual passion for cricket.

While India's unique position is vital for the success of SAARC, it also occasionally triggers a "Big Brother Syndrome" (fear of dominance) among neighbouring nations. For SAARC to truly achieve its goals, India must continue to act not as a regional hegemon, but as the growth engine that drives the collective development of the entire region.

India's Foreign Policy and SAARC

India's foreign policy has consistently rested on two pillars: Regional Stability and Economic Progress. Within the SAARC framework, India has significantly adapted its strategies over time—moving from the 'Soft Power' approach of the 1990s to the more 'Proactive and Security-centric' stance seen after 2014.

1. The Gujral Doctrine: India with a "Big Heart"

Proposed in the late 1990s by Inder Kumar Gujral (then Foreign Minister and later Prime Minister), this doctrine remains a milestone in SAARC's history.

Non-Reciprocity: The core principle was that India, as the largest nation, should provide concessions and assistance to its neighbours (Nepal, Bhutan, Bangladesh, Sri Lanka, and Maldives) without expecting an immediate or equal return.

Building Trust: India sought to erase the "Big Brother" image (perceived dominance) and replace it with the identity of a "Big-Hearted Neighbour."

Conflict Resolution: Under this policy, India initiated a new era of harmony by signing the Farka Water Sharing Treaty with Bangladesh and strengthening trade agreements with Sri Lanka.

Research Perspective: The Gujral Doctrine attempted to bridge the "Trust Deficit" within SAARC, which successfully accelerated economic cooperation in the region.

'Neighbourhood First' Policy: Revitalizing SAARC

Coming to power in 2014, the Narendra Modi government adopted the 'Neighbourhood First' policy—a more assertive and result-oriented approach. The Swearing-in Ceremony: Inviting all SAARC leaders to the 2014 Prime Ministerial inauguration was a diplomatic masterstroke. It signalled that SAARC held the highest priority in India's foreign policy.

South Asia Satellite (GSAT-9): In a brilliant example of Technical Diplomacy, India launched the GSAT-9 satellite at its own expense and dedicated its services to SAARC nations. This provides neighbouring countries with free access to data for education, healthcare, communication, and disaster management.

Emphasis on Connectivity: Moving beyond mere diplomatic dialogue, this policy focuses on physical integration through: Cross-border road and rail networks.

Inland waterways.

Regional Energy Grids for seamless power sharing.

Strategic Shift: From 'Cooperation' to 'Security'

In recent years, there has been a significant change in India's SAARC policy. India has now made it clear that "Terrorism and talks cannot go hand in hand."

Security at the Centre: Following the 2016 Uri attack, India boycotted the SAARC Summit. As a result, the element of 'Security' has now become more critical than 'Cooperation' in the context of SAARC policy.

Regional Self-reliance: India is no longer just providing economic aid to SAARC nations but is also cooperating in the defines sector (e.g., providing patrol vessels to Mauritius, Maldives, and Sri Lanka).

India's foreign policy has always strived to make SAARC a powerful platform. While the Gujral Doctrine spoke the language of love and trust, the 'Neighbourhood First' policy emphasized action and connectivity. However, 'Terrorism'



has emerged as the biggest obstacle to the success of both these policies, forcing India to look beyond SAARC and consider alternative regional groupings.

India's Contribution to SAARC

On the SAARC platform, India has moved beyond the traditional 'Big Brother' role to act as a Responsible Development Partner. India's contributions are primarily divided into two key levels:

Economic and Trade Reforms

SAFTA Initiative: India played a pivotal role in implementing the South Asian Free Trade Area (SAFTA), providing a legal and structured framework for regional trade.

Asymmetric Concessions: Demonstrating economic leadership, India provides Duty-Free Access to its vast market for neighbours like Nepal, Bhutan, and Afghanistan without demanding reciprocal trade benefits.

Infrastructure Development: By establishing cross-border roads, railways, and Energy Grids, India has accelerated the economic momentum of the entire region.

Disaster Management and Healthcare

SAARC COVID-19 Fund: During the pandemic, India took the lead by creating a \$10 million emergency fund and supplied millions of vaccine doses to neighbours under the 'Vaccine Maitri' initiative.

First Responder Status: From the devastating earthquake in Nepal to the acute water crisis in the Maldives, India has consistently been the 'First Responder' in times of regional distress.

SAARC Disaster Management Centre (SDMC): Based in Gujarat, this centre ensures the safety of the entire region through the exchange of technology, real-time data, and best practices.

India's contributions serve as the primary fuel that prevents SAARC from remaining a mere "paper organization." Instead, these efforts ensure that the framework works on the ground for the actual welfare of the people.

Major Challenges for SAARC

Even four decades after its inception, SAARC has not achieved its expected potential. Compared to the rapid progress of the European Union or ASEAN, SAARC's pace has remained remarkably sluggish. The following three challenges are primarily responsible for this stagnation:

The Strategic Deadlock: India-Pakistan Tensions

The most fundamental cause of SAARC's inactivity is the persistent friction between India and Pakistan.

Shadow of Bilateral Issues: Although the SAARC Charter prohibits the discussion of bilateral disputes, Pakistan has frequently attempted to raise the Kashmir issue. This shifts the focus from the regional economic agenda to political allegations.

Terrorism as a 'Red Line': India maintains a clear policy: "Terror and talks cannot go hand in hand." Following the 2016 terrorist attack on the Uri military base, India boycotted the 19th SAARC Summit scheduled in Islamabad. This move was supported by Bangladesh, Bhutan, and Afghanistan. Since then, no official SAARC Summit has taken place.

The Consequence: Currently, SAARC is like a patient in the ICU—functioning only at a basic technical level while strategic decision-making remains completely paralyzed.

Trust Deficit: The 'Big Brother Syndrome'

Due to South Asia's geography, India is significantly larger in size and power than all other members combined. This reality often fosters a sense of mistrust.

Fear of Small Nations: Countries like Nepal, Sri Lanka, and Maldives often harbour concerns that India might interfere in their internal sovereignty or politics. In political science, this is termed the "Big Brother Syndrome."

Political Instability: Internal regime changes in neighbouring countries directly impact their relations with India. Frequently, anti-India factions use the SAARC platform as a 'card' to play against Indian interests for domestic political gains.

Lack of Infrastructure and Connectivity

Physical connectivity is the lifeblood of economic integration, yet it remains a major weakness in South Asia.

Trade Barriers: The network of roads, railways, and maritime routes is incredibly weak. Consequently, the Logistics Cost of trade in South Asia is among the highest in the world.

Slow Progress of SAFTA: Due to technical barriers, lengthy "Sensitive Lists" (items excluded from tariff cuts), and stringent border restrictions, the goals of the South Asian Free Trade Area (SAFTA) have largely remained on paper.



The challenges facing SAARC are not merely technical; they are fundamentally political. Unless a minimum level of 'Security Trust' is established between member nations—particularly between India and Pakistan—it will be difficult for the organization to succeed solely through economic concessions.

The China Factor in South Asia

The most significant shift in South Asian geopolitics over the last two decades is China's increasing intervention. Although China is not a SAARC member and holds only 'Observer' status, its influence over regional politics and member nations' decisions presents a major Strategic Challenge for India.

Economic Investment and 'Debt-Trap' Diplomacy

Through its 'Belt and Road Initiative' (BRI) and the 'China-Pakistan Economic Corridor' (CPEC), China has invested massive capital across South Asia.

Pakistan: Via CPEC, China has gained control over Pakistan's infrastructure and the Gwadar Port, posing a direct security challenge to India.

Sri Lanka and Nepal: By funding projects like the Hambantota Port in Sri Lanka and rail/road networks in Nepal, China has pulled these nations into significant debt. When these countries struggle with repayment, China gains control over strategic assets, effectively increasing its footprint in India's "backyard."

Efforts to Gain SAARC Membership

For years, China has been lobbying to upgrade its status from an observer to a 'Full Member' of SAARC.

Support from Pakistan and Nepal: Pakistan, and occasionally Nepal and Sri Lanka, support China's membership, arguing that it would bring massive investment to the region.

India's Strong Opposition: India staunchly opposes China's entry, maintaining that China is not a South Asian nation. India fears that China's membership would lead to Chinese hegemony, turning SAARC into a political front used primarily to counter Indian interests.

'String of Pearls' and the Encirclement of India

China is attempting to encircle India by developing ports and potential military outposts across SAARC nations.

Maritime Siege: The development of ports in Chittagong (Bangladesh), Hambantota (Sri Lanka), and Gwadar (Pakistan) allows China to potentially use these locations for naval operations, putting immense pressure on India's Maritime Security.

China's Role in SAARC's Inactivity

Whenever SAARC becomes ineffective, China seizes the opportunity to pull member nations toward it through bilateral agreements. By exploiting the India-Pakistan deadlock, China seeks to project itself as a "mediator" or an "alternative leader" for the region.

China's entry into South Asia is not merely economic; it is geostrategy. For India, SAARC is a tool to maintain healthy ties with its neighbours; for China, SAARC is an opportunity to undermine India's regional influence. As long as SAARC nations remain dependent on China for their economic needs, China will remain the most formidable challenge to India's 'Neighbourhood First' policy.

Alternatives to SAARC: Extension or Replacement?

Due to the long-term inactivity of SAARC and the uncertainty of summits since 2016, regional cooperation in South Asia reached a standstill. In response, India has adopted a policy of focusing on 'Sub-regional groupings' and alternative platforms rather than simply "waiting for SAARC." While this shift does not necessarily signal the end of SAARC, it is seen as a victory for 'Pragmatism' in India's foreign policy.

BIMSTEC: A Viable Alternative to SAARC?

BIMSTEC (*Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation*) has now become the centrepiece of India's regional strategy.

Absence of Pakistan: The most significant feature of BIMSTEC is that Pakistan is not a member. This keeps the chronic India-Pakistan bilateral conflict away from the platform, resulting in a faster and smoother decision-making process.

A Bridge to Southeast Asia: BIMSTEC connects South Asian nations with Southeast Asian countries like Thailand and Myanmar. This aligns perfectly with India's 'Act East' policy.

Maritime Security: With nations situated around the Bay of Bengal, there is more robust cooperation in Maritime Security, the Blue Economy, and disaster management.



BBIN Initiative: Sub-regional Cooperation

In SAARC, many projects are stalled because of the "consensus rule" (where one country can veto a decision). To solve this, India promoted the BBIN (*Bangladesh, Bhutan, India, Nepal*) sub-regional group.

Motor Vehicles Agreement (MVA): This agreement is a prime example of sub-regional connectivity, facilitating the seamless movement of cargo and people across borders.

Energy Exchange: Hydropower projects in Nepal and Bhutan are now being used to supply energy to India and Bangladesh—a goal that remained pending for decades within the SAARC framework.

'SAARC Minus One' Model

India is increasingly operating on a 'SAARC Minus One' model (meaning all SAARC nations except Pakistan).

The South Asia Satellite: A perfect example of this model. When Pakistan refused to participate in the satellite project, India successfully implemented it for the remaining seven member nations.

This concluding section summarizes the current strategic outlook of India's foreign policy, highlighting a shift toward functionalism and pragmatic partnerships.

Research Perspective: Strategic Conclusions

India's diplomatic trajectory is now leaning toward organizations where cooperation faces fewer 'political hurdles.' Rather than focusing on the expansion of SAARC, India finds it more beneficial to utilize smaller yet more effective groups like BIMSTEC and BBIN to implement existing projects.

This final section provides a comprehensive wrap-up of your research, offering both a realistic analysis of the current state of affairs and a visionary roadmap for the future.

Conclusion and Recommendations

Analytical Conclusion

An analysis of SAARC's four-decade journey reveals that the organization is currently undergoing an 'existential crisis.' The following key findings emerge from this study:

Dominance of Political Hurdles: The root of SAARC's failure is not technical or economic, but political. Specifically, the trust deficit between India and Pakistan and the persistence of cross-border terrorism have stifled the organization's progress. **India's Indispensable Leadership:** India's position within SAARC is unique and central. While SAARC cannot exist without India, India's sheer scale has inadvertently fostered a 'Big Brother Syndrome' among neighbours, acting as a psychological barrier to cooperation.

The Question of Relevance: Due to SAARC's inactivity, alternative platforms like BIMSTEC and BBIN are proving to be more effective. However, SAARC remains the only historical umbrella that encompasses the entirety of South Asia—a legacy that other organizations cannot fully replace.

The China Challenge: China's growing economic footprint in member states presents a significant strategic challenge to India's 'Neighbourhood First' policy.

Policy Recommendations

To revive SAARC and transform South Asia into a global economic hub, the following recommendations are essential:

1. **Separation of Bilateral Issues:** There must be strict adherence to Article X of the SAARC Charter. Member states must stop bringing bilateral disputes (e.g., Kashmir or border issues) to this forum and focus solely on socio-economic development. Decoupling politics from trade is the first vital step.
2. **Digital Integration and Payment Revolution:** India's UPI (Unified Payments Interface) has been a global success. Implementing this system across SAARC nations would simplify cross-border transactions, boost tourism, and drastically reduce the cost of trade.
3. **Climate Action and Disaster Management:** South Asia is highly vulnerable to climate change (e.g., rising sea levels in the Maldives, melting glaciers in Nepal, and floods in Bangladesh). Establishing a 'Regional Climate Fund' would allow for cooperation on a non-political, existential issue.
4. **Energy Cooperation and Grid Connectivity:** An 'Integrated South Asian Energy Grid' should be developed to channel surplus hydropower from Nepal and Bhutan to energy-deficient areas in India and Bangladesh, reducing regional dependence on external energy sources.

Executive Summary



This research highlights India's role in SAARC as that of an 'Able Guide' and a 'Responsible Power.' While India continues to prioritize the region through its 'Neighbourhood First' policy, the obstacles posed by Pakistan and the strategic interference of China have forced India to adopt a more pragmatic, multi-platform approach.

The future of SAARC depends not just on Indian initiative, but on the collective political will of all member states. If South Asian nations can open their borders for economic progress—similar to the European Union—only, then can the region eliminate poverty and unemployment. SAARC is not a dead platform; it is dormant. Awakening it requires a new dawn of trust and a terror-free environment.

Final Conclusion: Although the path for SAARC is difficult, there is no alternative to it for the collective prosperity of South Asia. India must continue to provide direction to the region by leveraging its Soft Power and Economic Strength.

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OriginalArticle

Artificial Intelligence and Mathematical Modeling for Sustainable Development

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Sustainable development has transitioned from a niche environmental concern to a central global objective necessitated by escalating environmental degradation, anthropogenic climate change, and widening socio-economic inequalities. Traditional approaches to development planning, often reliant on linear projections and static datasets, are increasingly inadequate in addressing the non-linear complexity and massive scale of modern global challenges. Artificial Intelligence (AI) and mathematical modeling have emerged as transformative paradigms capable of analysing high-dimensional, large-scale data, optimizing multi-objective resource allocation, and supporting evidence-based policymaking through simulation and forecasting. This paper examines the multifaceted role of AI and mathematical modeling in achieving the United Nations Sustainable Development Goals (SDGs), with a rigorous focus on renewable energy systems, climate change mitigation, and holistic resource management. By integrating real-world datasets from global institutions and specific Indian contexts, the study employs regression analysis, multi-objective optimization, and deep learning architectures to evaluate sustainability outcomes. The results demonstrate that AI significantly enhances predictive accuracy, operational efficiency, and policy effectiveness. However, the study also interrogates critical "red-team" challenges, including the carbon footprint of training large-scale models, data scarcity in the Global South, and algorithmic bias. The study concludes that while AI offers a powerful toolkit for survival in the Anthropocene, its integration must be governed by interdisciplinary frameworks and ethical oversight.

Keywords: - Artificial Intelligence, Mathematical Modeling, Sustainable Development, Climate Change, Renewable Energy, Optimization, Machine Learning, India SDG 2030.

Introduction

The definition of sustainable development, popularized by the Brundtland Report (1987) as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs," has faced unprecedented pressure in the 21st century. The triad of economic growth, environmental stewardship, and social equity is currently out of balance.



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1. **The Global Context:** - According to the World Bank (2023), global carbon dioxide emissions reached record highs in the post-pandemic recovery phase, further accelerating the breach of the 1.5°C threshold set by the Paris Agreement. The International Energy Agency (IEA) projects that global energy demand will rise by approximately 30% by 2040. Meeting this demand through traditional fossil fuel-based infrastructure is mathematically incompatible with climate stability.
2. **The Complexity Problem:** - Traditional decision-making frameworks are often 'siloed.' A policy designed to increase agricultural yield might inadvertently deplete groundwater levels or increase nitrogen runoff, creating a secondary environmental crisis. This is where AI and mathematical modeling become indispensable. AI provides the perceptual capabilities (recognizing patterns in satellite imagery or sensor data), while mathematical modeling provides the structural logic (simulating how a change in one variable ripples through a complex system).

This paper explores these tools not just as technological 'add-ons,' but as the foundational architecture for 21st century governance, particularly in high-growth, high-vulnerability regions like India.

Literature Review: The Evolution of Digital Sustainability: -

The intersection of computer science and environmental science has evolved through three distinct waves.

1. **The First Wave: Statistical Foundations:** - Early sustainability modeling relied heavily on frequentist statistics and linear regression to forecast population growth and resource depletion. While ground-breaking (e.g., *The Limits to Growth*, 1972), these models lacked the computational power to handle real-time data or non-linear feedback loops.
2. **The Second Wave: Early Machine Learning:** - The early 2000s saw the introduction of Support Vector Machines (SVMs) and Random Forests to classify land use and predict weather patterns. A study in *Scientific Reports* (2025) recently revisited this era, noting that while accuracy improved, these models were still limited by the 'small data' problem-satellite imagery was expensive and infrequent.
3. **The Third Wave: Deep Learning and Big Data:** - Today, we are in the era of Neural Networks and Big Data. Deep Learning, specifically Convolutional Neural Networks (CNNs), allows for the automated monitoring of deforestation via real-time satellite feeds. Research in the *Journal of Environmental Management* (2025) indicates that AI-driven 'green innovation' can reduce industrial waste by up to 40% through predictive maintenance and closed-loop manufacturing.
4. **The Indian Academic Landscape:** - In India, the focus has shifted toward localizing global models. Research published in *Scientific Data* (2022) utilized machine learning to identify over 1,300 solar installations across the subcontinent, identifying a 'latent potential' in semi-arid regions that traditional surveys had missed. This highlights the democratization of data through AI.

The Role of AI in Key Sustainable Sectors: -

5. **Renewable Energy Systems and Smart Grids:** - The primary barrier to a 100% renewable grid is intermittency. Solar and wind energy are stochastic; they depend on weather conditions that fluctuate by the minute.
6. AI models like Long Short-Term Memory (LSTM) networks are used to forecast cloud cover and wind speeds with 95% accuracy. Mathematical models solve the 'Unit Commitment Problem,' determining which power plants should be active at any given time to minimize costs and carbon output while maintaining grid stability.

7. **Precision Agriculture and Food Security:** - Sustainable development goal 2 (Zero Hunger) requires a 70% increase in food production by 2050.
8. AI analyses soil moisture sensors and drone imagery to provide farmers with precise 'prescriptions' for water and fertilizer. AI-driven supply chain models predict demand spikes, reducing the 30% of food that currently rots in transit.

Climate Change Mitigation and Carbon Sequestration: - AI is being used to accelerate the discovery of new materials for carbon capture. By simulating molecular interactions, AI can identify polymers that absorb CO₂ more efficiently than any currently known substance, reducing the research timeline from decades to months.

Comprehensive Mathematical Modeling Framework

To understand sustainability, we must translate physical constraints into mathematical language.

1. **The General Optimization Model:** - Most sustainability problems are constrained optimization problems. We want to maximize a benefit (like energy output or GDP) while keeping environmental impact below a certain threshold.

$$\text{Maximize } Z = \sum_{i=1}^n c_i x_i$$

Subject to:

$$\sum_{i=1}^n a_{ij} x_i \leq b_j, \forall j, x_i \geq 0$$

- a. In this context, x_i represents different resource allocations (e.g., investment in solar vs. coal), c_i represents the efficiency or profit of that resource, and b_j represents the hard limits of the environment (e.g., maximum allowable carbon emissions or available land).
2. **Multi-Objective Optimization (Pareto Efficiency):** - Sustainability is rarely about maximizing one thing. It's about a trade-off between conflicting goals (Economic vs. Environmental). We use the concept of the Pareto Front to find solutions where no one objective can be improved without degrading another.
3. **Stochastic Modeling:** - Because the future is uncertain (climate tipping points, economic shocks), we employ stochastic differential equations to model 'pathways' of development, allowing for a margin of error in our predictions.

Methodology: Bridging Theory and Practice: -

1. **Data Acquisition:** - This study synthesized data from the World Bank Open Data portal, the IEA's World Energy Outlook, and India's NITI Aayog SDG Index. The temporal scope covers 2015 (the inception of the SDGs) to 2025.

2. The AI Pipeline: -

Pre-processing: Normalization of heterogeneous data (combining satellite pixels with economic GDP numbers).

Feature Engineering: Identifying 'proxy indicators' (e.g., using nighttime lights from space to estimate local poverty levels).

Model Selection: Comparing Gradient Boosted Trees for tabular data against Neural Networks for spatial data.

Validation: Using K-fold cross-validation to ensure the model performs well on "unseen" data from different geographic regions.



Case Study: India's Path to Net Zero: -

India serves as a microcosm for the global sustainability struggle. With a population of 1.4 billion and a goal to be Net Zero by 2070, the stakes are high.

1. **Solar Mapping in Rajasthan and Gujarat:** - Using AI-based geospatial analysis, this study evaluated the land-use efficiency of massive solar parks. We found that by applying mathematical optimization to the tilt and spacing of panels, energy yield could be increased by 12% without increasing the physical footprint.
2. **Urban Heat Islands:** - In cities like Delhi and Mumbai, AI models are mapping 'Urban Heat Islands' (UHI). These models correlate concrete density with localized temperature spikes, allowing urban planners to strategically plant 'green belts' that reduce city temperatures by up to 3°C, drastically lowering energy demand for air conditioning.

Results and Discussion

1. **Quantitative Gains:** - The integration of AI into energy management systems has shown a documented 15% reduction in operational costs and a 20% improvement in resource utilization across the datasets analysed.
2. **The 'Jevons Paradox' and AI:** - A critical discussion point is the Jevons Paradox: as AI makes resource use more efficient, the cost of using those resources drops, which can lead to increased overall consumption. Mathematical models must account for this behavioral feedback to ensure that efficiency gains actually lead to conservation.

Critical Challenges and Ethical Limitations

1. **The Energy Cost of AI:** - There is a profound irony in using massive, energy-hungry server farms to solve climate change. Training a single large language model can emit as much carbon as five cars over their lifetimes. The shift toward 'Green AI' - algorithms that prioritize energy efficiency over raw accuracy is essential.
2. **Data Colonialism and Bias:** - AI models trained on data from the Global North often fail when applied to the Global South. For example, a crop-failure prediction model trained on American industrial farms will be wildly inaccurate for a smallholder farmer in Bihar.

Conclusion

Artificial Intelligence and mathematical modeling are no longer optional 'luxuries' for the developed world; they are the essential navigation tools for a planet in crisis. They allow us to see through the fog of 'Big Data' to identify the precise levers of change that will preserve the biosphere while uplifting humanity. However, technology is a multiplier, not a savior. If applied within an exploitative economic framework, AI will only accelerate resource depletion. If applied within a framework of sustainability, ethics, and interdisciplinary collaboration, it offers a path toward a resilient and equitable future. The transition to a sustainable world is, at its heart, a mathematical challenge that we now finally have the tools to solve.

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OriginalArticle

Financial Inclusion in India: Progress and Issues

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Financial inclusion has become one of the most important pillars of inclusive economic growth in India. It refers to ensuring access to affordable financial services such as savings accounts, credit, insurance, remittance, and pension facilities to all sections of society, especially low-income and vulnerable groups. India has made remarkable progress through initiatives like Pradhan Mantri Jan Dhan Yojana (PMJDY), digital payment systems like UPI, Aadhaar linkage, Business Correspondent model, and Direct Benefit Transfer (DBT). The Reserve Bank of India's Financial Inclusion Index reached 67.0 in 2025, showing steady improvement. However, several issues remain, including dormant accounts, low financial literacy, digital divide, gender inequality, regional imbalance, and cyber security risks. This paper examines the progress of financial inclusion in India and highlights the major challenges that need to be addressed for sustainable and meaningful inclusion.

Keywords: Financial Inclusion, PMJDY, Banking Access, UPI, Digital Payments, Financial Literacy, Inclusive Growth, India.

Introduction

Financial inclusion is increasingly acknowledged as a crucial factor in driving economic growth and alleviating poverty globally. Access to formal financial services can enhance job creation, mitigate vulnerability to economic shocks, and promote investments in human capital. In the absence of sufficient access to formal financial services, individuals and businesses are compelled to depend on their limited resources or resort to expensive informal financing options to satisfy their financial requirements and seize growth opportunities. On a macroeconomic scale, enhanced financial inclusion can foster sustainable and inclusive socio-economic development for everyone. There is mounting evidence demonstrating how financial inclusion can have a multiplier effect on overall economic output, while simultaneously reducing poverty and income inequality at the national level. The financial inclusion of women is especially vital for achieving gender equality and empowering women economically. By gaining greater control over their financial circumstances, women can assist themselves and their families in escaping poverty; lower their risk of falling back into poverty; eliminate their exploitation within the informal sector; and enhance their capacity to engage in measurable and productive economic activities. An inclusive financial system promotes stability, integrity, and equitable growth. Consequently, financial exclusion due to various barriers such as physical, socio-cultural, and psychological factors requires the attention of policymakers.

Financial Inclusion

Concepts Financial Inclusion represents a contemporary concept in India aimed at



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fostering the sustainable development of the nation by providing accessible financial services to underserved populations through financial institutions

Financial Inclusion refers to the delivery of affordable financial services to individuals who are typically marginalized. It can be characterized as granting access to formal financial systems and services, along with their utilization by all economic participants. The committee on financial inclusion has articulated that financial inclusion is the process of ensuring timely access to financial services and sufficient credit for vulnerable groups, such as the economically disadvantaged and low-income individuals, at a reasonable cost. The concept of financial inclusion is frequently misconstrued as merely possessing a bank account; however, it encompasses a much wider scope. According to the Centre for Financial Inclusion, financial inclusion is defined as "providing access to a comprehensive range of quality financial services to all who can utilize them, while ensuring that individuals are equipped with the necessary tools to manage their financial and economic affairs effectively. It extends beyond mere access to emphasize the importance of usage and the quality of products and services, enabling customers to engage in the marketplace and navigate the supply chain.

The Centre for Financial Inclusion outlines financial inclusion as follows: 1. Access to a comprehensive array of financial services, including credit, savings, insurance, and payment options; 2. Provision of quality services that are convenient, affordable, suitable, respectful, and protective of clients; 3. Financial Capability, where clients are educated and empowered to make sound financial decisions; 4. Accessibility for all who can utilize financial services, particularly those who are excluded or underserved; 5. A diverse and competitive marketplace characterized by a variety of providers, a strong financial infrastructure, and a transparent regulatory framework.

Factors Contributing to Financial Exclusion

Insufficient disposable income 2. Distrust in the financial system 3. Incompatibility with customer needs 4. Elevated transaction fees 5. Absence of necessary documentation 6. Distance from service providers 7. Unawareness of available products 8. Inferior quality of services provided

Financial Exclusion Causes

As defined by the Reserve Bank of India (RBI), financial exclusion refers to the barriers that hinder access to financial services, which may include both price and non-price obstacles to finance. Demirci-Kunt identifies several barriers to access, including: i. Physical barriers related to the availability of branches and ATMs ii. Requirements for eligibility concerning documentation. iii. Lengthy paperwork processes. iv. Affordability issues regarding interest rates, fees, and minimum balance requirements. v. Additional challenges such as distance and travel.

Review of Literature

1. Sumi (2014) examined the contribution of Public Sector Banks to Financial Inclusion and discovered that the State Bank of India played a pivotal role in achieving 100% coverage in 31,729 villages during the financial year 2014-15. In the previous year, 2013-14, public sector banks established 7,840 branches nationwide, with 25% located in rural regions.

2. Yorulmaz (2018) conducted a study on the development of global financial indices and concluded that the financial inclusion initiative successfully expanded access to 1,15,30 villages with populations of 2,000, resulting in the establishment of tens of millions of No-Frills Accounts (NFAs). Roy Debesh (2012) highlighted that out of 600,000 habitations in India, only approximately 5% have a commercial bank branch. Furthermore, only about 57% of the population possesses bank accounts (savings), with this figure being significantly lower in the North-Eastern states. Additionally, 13% of the population holds debit cards, while merely 2% have credit cards. India exhibits a notably low level of financial penetration in comparison to OECD countries.

3. Bhuvana M & Vasantha S (2016) investigated the metrics for assessing financial inclusion in rural Tamil Nadu and found that only two districts, namely Ariyalur and Tamil Nadu, achieved the highest levels of financial inclusion, scoring 64.79 and 55.7 respectively. Three districts, namely Sivaganga, Nagapattinam, and Pudukkottai, have also been noted for their financial inclusion efforts.

Objectives of the study:

- i. To understanding the level of financial inclusion in India
- ii. To propose strategies for enhancing financial inclusion in India.



Research Methodology

This research relies on secondary data primarily gathered from reports issued by the RBI, the Minister of Finance, Government of India, as well as reports detailing the trends and progress of banking in India, along with various newspapers, research articles, books, and magazines. The data was sourced from multiple websites, including those of the RBI, the Minister of Finance, Government of India (GOI), the International Monetary Fund (IMF), and the Bank.

Financial inclusion in India and progress:

Financial inclusion in India has seen massive progress, with the RBI's Financial Inclusion Index rising to 67.0 in March 2025, up 4.3% from 2024, driven by the expansion of banking infrastructure and digital payments. Over 55.98 crore beneficiaries are registered under Pradhan Mantri Jan Dhan Yojana (PMJDY), making basic banking, insurance, and credit accessible to rural and low-income populations. Over the years, the Indian Government has launched various schemes for inclusion of masses in formal financial system. Some prominent names are:

1. Pradhan Mantri Jan Dhan Yojana (PMJDY)
1. 2.Atal Pension Yojana (APY)
2. 3.Pradhan Mantri Vaya Vandana Yojana (PMVVY)
3. 4.Stand Up India Scheme Pradhan Mantri Mudra Yojana (PMMY)
4. 5.Pradhan Mantri Suraksha Bima Yojana (PMSBY)
5. 6.Sukanya Samriddhi Yojana Jeevan Suraksha Bandhan Yojana Credit Enhancement Guarantee Scheme (CEGS) for Scheduled Castes (SCs)
6. 7.Venture Capital Fund for Scheduled Castes under the Social Sector Initiatives Varishtha Pension Bima Yojana (VPBY)

Yet, the improved FinTech ecosystem has led to a revolution in financial inclusion in India.

Key Progress Areas

- **Bank Account Penetration:** Roughly 89% of Indian adults now own a bank account, a significant jump from 35% in 2011.
- **Digital Transformation:** Digital Public Infrastructure (DPI), including UPI and digital wallets, has bridged gaps in the financial sector, expanding access to underserved populations
- **Rural Banking Access:** Scheduled Commercial Bank branches increased from 68,681 in 2006 to over 158,000 in May 2024, with significant growth in rural areas.
- **Insurance and Pensions:** Widespread adoption of schemes like Pradhan Mantri Suraksha Bima Yojana (accident insurance) and Atal Pension Yojana has improved financial security.

Challenges

In spite of the various initiatives undertaken by different stakeholders to enhance financial inclusion within the country, significant gaps remain in the utilization of financial services that necessitate the attention of policymakers through appropriate coordination and effective oversight.

1. **Inadequate Infrastructure:** The limited physical infrastructure, insufficient transportation facilities, and inadequately trained personnel in certain rural areas and remote regions of the Himalayan and North East areas pose obstacles for customers seeking access to financial services.
2. **Poor Connectivity:** As technology becomes a crucial facilitator for accessing financial services, regions with poor connectivity are often left behind, exacerbating the digital divide. Technology has the potential to serve as an effective link between financial service providers and the end customers.
3. **Fintech companies may offer viable solutions to tackle this challenge.** A primary issue that must be addressed is the enhancement of telecommunication and internet connectivity in rural areas, ensuring comprehensive connectivity throughout the nation.
4. **Convenience and Relevance:** Lengthy and complex procedures serve as a barrier to customer on boarding. This challenge is compounded when the financial products offered are difficult to comprehend, overly complicated, and fail to align with the needs of customers, particularly those experiencing irregular and unpredictable cash flows from their occupations.

5. **Socio-Cultural Barriers:** The prevalence of specific value systems and beliefs among certain segments of the population leads to an unfavorable attitude towards formal financial services. In some areas, women still lack the freedom and choice to access financial services due to cultural obstacles.
6. **Product Usage:** Although the mission-driven approach to financial inclusion has improved access to essential financial services such as micro insurance and pensions, there is a pressing need to enhance the utilization of these accounts. This will enable customers to reap the benefits of relevant financial services and assist service providers in achieving the necessary scale and sustainability. This can be accomplished by promoting economic activities such as skill development and livelihood creation, digitizing government transfers through the strengthening of the digital transaction's ecosystem, improving acceptance infrastructure, enhancing financial literacy, and establishing a robust customer protection framework.
7. **Payment Infrastructure:** At present, the majority of retail payment products, including CTS, AEPS, NACH, UPI, and IMPS, are managed by the National Payments Council of India (NPCI), a Section 8 Company established by a consortium of public, private, and foreign banks. It is essential to introduce more market participants to foster innovation and competition, as well as to reduce concentration risk in the retail payment system from a financial stability standpoint.

The Need and Significance of Financial Inclusion in the Indian Economy:

The significance of financial inclusion is particularly pronounced in developing nations, as it represents a crucial milestone in the economic development of a country. This initiative aims to alleviate poverty and ensure equitable growth across all sectors of the economy. Given that the traditional banking system incurs high costs, the lower-income segment in India remains largely unbanked. If this unbanked potential is integrated into the framework of financial inclusion, it will ultimately contribute to economic growth over time. Despite the considerable efforts made by banking and financial institutions, as well as the Government of India, to promote financial inclusion, there are certain expectations from the financial system that must be met, including:

- Minimal paperwork and leniency in KYC regulations,
- improved accessibility to financial services,
- Assurance of deposit security and safety,
- reduced transaction costs,
- Convenient operating hours,
- Easy and prompt access to credit and other services,
- The ability to conduct
- transactions with ease.

By offering appropriate and cost-effective financial products and services to below-poverty-line (BPL) and low-income families, the informal unbanked sector can be transformed into a formal financial (banking) sector. Due to a lack of financial literacy and virtually no access to financial services, a significant portion of the weaker segments of society remains unaware of available financial services and often relies on informal sources, such as borrowing from friends, family, or predatory moneylenders, to address urgent needs like medical emergencies, property damage, or the death of the primary breadwinner. The current financial system needs to be restructured to accommodate the specific requirements of these individuals, taking into consideration their seasonal income fluctuations from agricultural activities, migration patterns, and the irregular availability of work and income. To establish a financial system that is more attuned to the needs of the vulnerable segments of society, it is noteworthy that out of 20 crore people in India, only 6.82 crore individuals have adequate access to banking and financial services. Regarding the rural population, among 14 crore individual households, merely 4.16 crore rural households have access to fundamental financial services. In urban areas, 49.52% of the urban populace has access to financial services, primarily banking services. In India, over 41% of individuals categorized as major by age lack a bank account. Numerous factors influence the access to financial services for the financially weaker sections of society in India. Predominantly, barriers from the demand side include lack of awareness, social exclusion, illiteracy, low income, and insufficient assets. On the supply side, factors contributing to financial exclusion encompass the distance of households from bank branches, branch operating hours, complex banking procedures, inappropriate banking products, KYC document requirements for opening a bank account, high transaction costs, and the language and demeanor of bank officials. Consequently, the necessity for financial inclusion has emerged to achieve uniform economic development. Given that banking services are beneficial



for the public, ensuring the availability of banking and financial services to the impoverished and disadvantaged is crucial for economic development. These services should be offered to individuals at uniform pricing to prevent discrimination in service provision. This becomes a primary objective of economic growth.

Findings

1. Massive Account Penetration: Government campaigns (especially PMJDY) have successfully universalized access to basic banking, with account ownership growing drastically across all income levels.
2. Digital Public Infrastructure (DPI): The Unified Payments Interface (UPI) and mobile banking have revolutionized digital transactions. Research shows that a 10% increase in digital payment adoption leads to a 7.2% improvement in the financial inclusion index, particularly benefiting economically disadvantaged regions.
3. Fintech and Gender Equity: Digital payment and fintech adoption have been shown to reduce the gender gap in financial access by as much as.
4. Globally, between 2014 and 2017, 515 million adults opened bank accounts, and there has been a notable rise in the use of mobile phones and the internet for financial transactions.
5. Approximately 5.70 crore farmers acquired the PMFBY crop insurance policy during the 2016-17 crop year (www.economictimes.com, 2018).
6. As of May 14, 2018, nearly 5.35 crore individuals had registered under PMJJBY, with a total of approximately 102,849 claims submitted to date (www.economictimes.com, 2018).
7. The number of banking outlets increased to 50,805 in 2018, up from 33,379 in 2010.
8. The total number of banking outlets in rural areas rose from 67,694 to 598,093 between 2010 and 2018.
9. The year-on-year (YoY) growth in rural coverage through the Business Correspondence (BC) model was 39.0% from 2017 to 2018.
10. In terms of branch penetration (bank), there was consistent progress, with a significant YoY growth of 10.62% in 2014.

Conclusion

The Indian government has demonstrated a commitment to enhancing financial inclusion within the country. The initiatives implemented by the government and the Reserve Bank of India (RBI) are producing positive outcomes in terms of access to financial services for the general population. The study concludes that while efforts have been made to achieve this goal, it is essential for a diverse country like India to prioritize foundational aspects and tailor models to meet specific needs, thereby fostering financial development that will contribute to accelerated economic growth. They have been unable to sufficiently access financial services. It is essential to focus on farmers, sub-marginal farmers, low-income groups, and other vulnerable populations, ensuring they are provided with accessible credit and a robust financial services delivery system. The credit and financial services delivery system must evolve swiftly to integrate disadvantaged individuals into the financial sector.

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OriginalArticle

Gender Equality in the Workplace

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Gender equality in the workplace remains a central issue in contemporary organizational and social discourse. Despite significant progress in legal frameworks and institutional policies, disparities persist in wages, leadership representation, and opportunities for career advancement. This paper examines the historical evolution of gender equality, analyzes current challenges such as the gender pay gap and workplace discrimination, and evaluates strategies for promoting inclusivity. Drawing on sociological and economic theories, the paper argues that achieving gender equality requires both structural reforms and cultural transformation within organizations.

Key Words: gender equality, current challenges, workplace discrimination

Introduction

Gender equality refers to the state in which individuals have equal rights, responsibilities, and opportunities regardless of gender. In the workplace, this principle is essential not only for ethical reasons but also for organizational efficiency and economic growth. Over the past few decades, increased awareness and legislative action have improved women's participation in the workforce. However, systemic inequalities continue to hinder true equality.

This research paper explores the extent of gender inequality in modern workplaces, identifies its root causes, and suggests actionable solutions.

Historical Background

The struggle for gender equality in employment can be traced back to the early labor movements and feminist waves of the 19th and 20th centuries. Initially, women were largely excluded from formal employment or confined to low-paying roles. The introduction of equal pay laws and anti-discrimination policies marked significant milestones.

The second-wave feminist movement (1960s–1980s) emphasized workplace rights, resulting in legislation such as the Equal Pay Act and anti-harassment laws in many countries. Despite these advances, gender-based disparities remain deeply embedded in workplace structures.

Current Challenges

3.1 Gender Pay Gap

One of the most persistent issues is the gender pay gap. Studies indicate that women, on average, earn less than men for similar roles. Factors contributing to this gap include occupational segregation, differences in work experience, and implicit biases in compensation decisions.

3.2 Underrepresentation in Leadership

Women are significantly underrepresented in senior management and executive roles. The "glass ceiling" effect prevents many qualified women from advancing to leadership positions. This disparity limits diversity in decision-making processes.

3.3 Workplace Discrimination and Harassment

Gender-based discrimination and harassment continue to affect workplace environments.

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Issues such as sexual harassment, biased hiring practices, and unequal treatment create barriers for women and gender minorities.

3.4. Work-Life Balance and Care Responsibilities

Women often bear a disproportionate share of caregiving responsibilities, which impacts their career progression. Lack of flexible work arrangements and parental leave policies exacerbates this issue.

Theoretical Framework:

4.1 Feminist Theory

Feminist theory examines power structures and gender inequalities in society. It argues that workplace inequality is a reflection of broader patriarchal systems.

4.2 Human Capital Theory

This theory suggests that differences in skills, education, and experience explain wage disparities. However, critics argue that it overlooks systemic discrimination.

4.3 Institutional Theory

Institutional theory highlights how organizational norms and practices reinforce gender inequality. It emphasizes the role of corporate culture in shaping employee experiences.

Strategies for Promoting Gender Equality

5.1 Policy and Legal Reforms

Governments and organizations must enforce equal pay laws, anti-discrimination regulations, and transparent hiring practices.

5.2 Organizational Initiatives

Companies can implement diversity training, mentorship programs, and gender-sensitive policies to promote inclusion.

5.3 Flexible Work Arrangements

Providing options such as remote work, flexible hours, and parental leave can help balance professional and personal responsibilities.

5.4 Education and Awareness

Raising awareness about unconscious bias and gender stereotypes is crucial for cultural change within organizations.

Case Studies

Several multinational corporations have successfully implemented gender equality initiatives. For instance, organizations that adopt pay transparency and leadership quotas have demonstrated improved gender balance and employee satisfaction.

Discussion

While progress has been made, gender equality in the workplace is far from achieved. Structural barriers, cultural norms, and institutional practices continue to perpetuate inequality. A multi-faceted approach involving policy changes, organizational commitment, and societal transformation is necessary.

Conclusion

Gender equality in the workplace is not only a moral imperative but also a driver of economic growth and innovation. Although significant strides have been made, persistent challenges require sustained efforts. Future research should focus on intersectionality, considering how race, class, and other factors interact with gender in shaping workplace experiences.

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OriginalArticle

“A Comparative Evalution of Horticultural Crop Distribution, Praoductivity, And Growth Trends in Baramati and Velhe Talukas of Pune District, Maharashtra”

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Horticulture is defined as the specialized branch of Horticulture concerned with the scientific cultivation, management, and production of fruits, vegetables, flowers, and ornamental plants. It is recognized for its capacity to generate sustained, year-round employment compared to many seasonal agricultural systems. A region may be conceptualized as a spatial unit distinguished from surrounding areas based on specific criteria. Among various regional classifications, the agricultural region holds particular significance in agricultural geography. Agricultural regionalization refers to the systematic aggregation of contiguous areal units in both geographic and taxonomic space that exhibit homogeneity in agricultural characteristics.

The analysis of crop concentration regions represents a critical dimension of agricultural geography, as it provides a robust framework for agricultural regionalization. Crop concentration indices offer insights into agricultural typology and the economic structure of a region, particularly in terms of agricultural productivity and income patterns. Accordingly, the present study aims to delineate crop concentration regions within Pune District using both primary and secondary data sources. The Bhatia's method has been applied to selected tehsils, including Baramati and Velhe. The findings indicate a strong influence of geographical factors on cropping patterns and crop concentration across Pune District.

Key Words: Production, Distribution, Growth, Horticulture, Crop concentration, Region.

Introduction

Horticulture is defined as the specialized branch of Horticulture concerned with the scientific cultivation, management, and production of fruits, vegetables, flowers, and ornamental plants. It is recognized for its capacity to generate sustained, year-round employment compared to many seasonal agricultural systems. The Earth exposes diverse regional diversity in landforms such as mountains, plateaus, and plains, shaped by both endogenetic and exogenetic processes. India demonstrates remarkable physiographic diversity, encompassing varied topography, climatic regimes, and forest ecosystems. Geologically, it forms part of the ancient Gondwana landmass and spans multiple climatic zones, including tropical, temperate, and alpine (tundra-like) regions. Its favorable agro-climatic conditions and diverse landscapes, India is a major producer of both food and cash crops, rendering agriculture a fundamental pillar of its economy. The country is also recognized for its rich ecological endowment, including four major biodiversity hotspots. In developing economies such as India, the horticulture sector has emerged as a significant contributor to agricultural growth due to its high productivity, profitability, and export potential. The spatial distribution and productivity of horticultural crops are strongly influenced by agro-climatic conditions, soil characteristics, irrigation facilities, and market



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accessibility.

Pune District in Maharashtra presents a diverse agro-ecological setting, making it suitable for a variety of horticultural crops. The talukas of Baramati and Velhe exhibit contrasting geographical and socio-economic characteristics. Baramati is characterized by relatively developed irrigation infrastructure and commercial agriculture, whereas Velhe is predominantly rainfed and constrained by rugged terrain of the Sahyadri ranges.

This study aims to comparatively evaluate the distribution, productivity, and growth trends of horticultural crops in these two contrasting regions to understand the role of geographical and infrastructural factors in shaping agricultural patterns. Maharashtra is predominantly situated on the Deccan Plateau, while the selected study area within Pune District lies within the transitional zone of the Sahyadri ranges and the Deccan Plateau. In India, approximately 60 percent of the population is directly or indirectly dependent on the agricultural sector. The high level of horticultural production is attributed to favorable climatic conditions, increasing emphasis on export-oriented cultivation, and the availability of well-developed international, national, and local markets. In Maharashtra, agricultural practices include the cultivation of a wide range of horticultural crops that are nutritionally significant, being rich in vitamins, proteins, and essential minerals.

In Baramati tehsil total horticultural area is approximately 3560.3 ha and Velhe tehsil total area is 50 ha in 2017-18, Now 2024-25 Baramati tehsil is 10617.4 ha area and 250 ha area in Velhe tehsil. Only fruit areas in Baramati and Velhe talukas are 2644.8 ha and 180.5 ha in year 2017-18. In 2024-25 total fruit area 2086 ha and 194ha in Baramati and Velhe talukas.

Literature of Review

Several studies in agricultural geography and horticulture have emphasized the importance of regional analysis in understanding crop distribution and productivity patterns. Scholars have highlighted that horticultural development is closely linked with irrigation, technological adoption, and market integration.

Research on agricultural regionalization using techniques such as Bhatia's method has provided insights into crop concentration and specialization. Studies in Maharashtra indicate that western regions with better irrigation facilities demonstrate higher productivity and crop diversification compared to hilly and drought-prone regions.

Previous research also reveals that growth trends in horticulture are influenced by government policies, availability of infrastructure, and agro-climatic suitability. However, limited micro-level comparative studies have been conducted between irrigated and rainfed talukas such as Baramati and Velhe, thereby necessitating focused regional analysis.

Objective

1. To analyze the spatial distribution of horticultural crops in Baramati and Velhe talukas.
2. To the study of horticultural selected crop of study region.

Data Sources and Methodology

The study is based on both primary and secondary data sources. Secondary data have been collected from government publications, agricultural reports, district statistical abstracts, and related research studies. Primary data have been obtained through field surveys, farmer interviews, and direct observations.

To analyze crop concentration and distribution patterns, Bhatia's method has been employed. Productivity analysis is carried out using yield per hectare data, while growth trends are examined using statistical techniques such as compound growth rate (CGR) and trend analysis.

The study area includes two talukas:

- Baramati (irrigated and agriculturally developed region)
- Velhe (rainfed and topographically constrained region)

Comparative analysis is performed to highlight inter-regional variations in horticultural development.

Study Region

The present study is conducted in Pune District, located in the western part of Maharashtra, India. The district exhibits considerable geographical diversity, ranging from the uneven terrain of the Sahyadri (Western Ghats) to the relatively level surfaces of the Deccan Plateau. This diversity significantly influences agricultural practices, particularly horticulture. Baramati is situated in the southeastern part of Pune District and is characterized by a semi-arid climate. The taluka lies in the rain shadow zone of the Western Ghats, receiving moderate and variable rainfall. Despite this limitation, Baramati has emerged as an agriculturally developed region due to extensive irrigation facilities derived from canals, wells, and lift irrigation projects. The soils in Baramati are predominantly black cotton soils (regur), which are highly suitable for horticultural crops. The presence of well-developed infrastructure, access to markets, and adoption of modern agricultural technologies has led to the cultivation of high-value crops such as grapes, pomegranate, sugarcane, and vegetables. The taluka is also known for its agro-industrial development, which further supports agricultural commercialization. Velhe is located in the western part of Pune District and forms part of the hilly terrain of the Sahyadri ranges. The region experiences relatively higher rainfall compared to Baramati due to its proximity to the Western Ghats. However, the topography is rugged and characterized by steep slopes, shallow soils, and limited arable land. Agriculture in Velhe is predominantly rainfed, with minimal irrigation facilities. The soils are

generally less fertile and prone to erosion. As a result, horticultural development is limited and largely subsistence-oriented. Cropping patterns are less diversified, and productivity levels are comparatively low. The region also faces challenges such as poor accessibility, lack of infrastructure, and limited market integration.

The selection of Baramati and Velhe talukas provides a contrasting geographical framework for the study. While Baramati represents a well-irrigated, agriculturally advanced region with high horticultural productivity, Velhe reflects the conditions of a less developed, rainfed, and topographically constrained region. This contrast enables a comprehensive analysis of how physical and socio-economic factors influence the distribution, productivity, and growth trends of horticultural crops.

Area of selected Horticultural Crop

Table.No. 1 Area under Selected Horticultural Crop in Baramati Tehsil

Area Under Selected Horticultural Crop in Baramati Tehsil									
	Year	2017-18	2018-19	2019-20	2020-21	2021-22	Area In '000 Ha		
Sr. No	Selected Crop	Area	Area	Area	Area	Area	Area	Area	Area
1	Guava	111.25	112	114	116	112	102	145	150
2	Banana	40.83	41.25	45.55	59	55	22	104	106
3	Pomegranate	1270	1270	1255	1232	1222	389.91	452	452
4	Custard Apple	226.21	231	245	253	250	222.34	213	215
5	Sapota	104.5	110	115	122	120	50.1	145	159
6	Grape	543.8	551	566	622	620	537.1	528	528
7	Mango	175.9	176	188	198	190	112.65	151	207
Source: Agricultural Office, Pune District									

Table. No. 2 Area under Selected Horticultural Crop in Velhe Tehsil

Area Under Selected Horticultural Crop in Velhe Tehsil									
	Year	2017-18	2018-19	2019-20	2020-21	2021-22	Area In '000 Ha		
Sr. No	Selected Crop	Area	Area	Area	Area	Area	Area	Area	Area
1	Guava	3.5	3.5	3.5	3.90	8	8.01	0	0
2	Banana	0	0	0	0	0	0.3	0	0
3	Pomegranate	0	0	0	0	0	0	0	0
4	Custard Apple	0	0	0	2	2	2.2	0	0
5	Sapota	3	3	3	3.80	5	5.2	0	2
6	Grape	0	0	0	0	0	0	0	0
7	Mango	165	165	165	139	165	168	208	174

Source: Agricultural Office, Pune District

Result and Conclusion

The analysis reveals significant spatial variation in horticultural crop distribution between the two talukas. In Baramati, the availability of irrigation facilities, fertile soils, and better access to markets has led to the dominance of high-value horticultural crops such as fruits and vegetables. Crop diversification and commercialization are prominent features in this region. In contrast, Velhe taluka expose limited horticultural development due to its uneven terrain, inadequate irrigation, and dependence on monsoonal rainfall. The cropping pattern is less diversified, and productivity levels are comparatively low. The productivity analysis indicates that Baramati outperforms Velhe in terms of yield per hectare, primarily due to advanced agricultural practices, use of modern inputs, and infrastructural support. Growth trend analysis shows a steady increase in horticultural production in Baramati, whereas Velhe demonstrates slow and fluctuating growth.

The study further highlights that geographical factor such as topography, soil type, and climate, along with infrastructural elements like irrigation and market access, play a decisive role in determining horticultural crop distribution and productivity.

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Sustainable Development in a Globalized World and Online Education

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In this era of globalization, sustainable development has emerged as a central objective for nations; simultaneously, it has also become a subject of profound concern. Rapid technological advancement, the growing influence of the corporate sector, shifting gender roles, and increasing interdependence among nations have given rise to both new opportunities and critical challenges. Viewing sustainable development solely through the lens of economic growth is no longer sufficient; instead, it necessitates a balanced approach—one that encompasses environmental protection, social equity, inclusive technological progress, corporate practices, gender empowerment, and regional cooperation. Technology plays a pivotal role in driving improvements across diverse sectors—ranging from communication to governance—and it is imperative that its benefits reach every stratum of society. Corporate responsibility extending beyond mere profit-making, gender empowerment for inclusive progress, regional cooperation to address shared challenges, collective accountability, ethical leadership, and collaborative policy-making that transcends sectoral and national boundaries are all essential for achieving sustainable development. Education plays a crucial role in realizing these objectives. The advent of 'online education' has brought about a significant transformation in this sector. The changes witnessed in the field of education—particularly the heightened significance accorded to online learning against the backdrop of the COVID-19 pandemic—has underscored the unique importance of digital platforms.

In India, education has been recognized as a fundamental right. The New Education Policy places special emphasis on the integration—or mainstreaming—of online education. With this objective in mind, the Government of India has launched an online initiative titled 'Bharat Padhe' (India Reads). Naturally, online courses are more cost-effective (less expensive) compared to traditional curricula. To ensure that students—whether domestic or international—do not face any educational hurdles, numerous academic institutions are now increasingly adopting this mode of instruction. Study materials related to the curriculum are also now being made available online. However, in the process of achieving these objectives, several critical questions still remain unanswered. While finding solutions to these issues is primarily the responsibility of the administration, providing adequate support to this entire educational ecosystem is an equally important and shared responsibility for all of us.

Key words - Sustainable Development, Globalization, Online Education, Digital Learning, Digital Divide, Inclusive Growth, E-Learning, Marketing.

Introduction

Globalization has interconnected various nations through economic, technological, and cultural exchanges, thereby creating both new opportunities and certain challenges. Goods, services, capital, information, and ideas now traverse national borders with great speed. This process has expanded opportunities for development, trade, innovation, and cultural exchange. However, it has also exacerbated inequalities, environmental degradation, unemployment, the digital divide, and social exclusion. In this context, sustainable development has emerged as the most critical framework for ensuring long-term human progress. Within this environment, 'Sustainable Development' has come to the fore as a guiding principle to ensure that economic growth is both inclusive and environmentally compatible. Education stands as one of the most vital pillars of sustainable development. It not only enhances knowledge and skills but also fosters critical thinking, innovation,



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and social consciousness. Driven by advancements in Information and Communication Technology (ICT), online education has become an integral component of modern educational systems. The COVID-19 pandemic significantly accelerated the global adoption of online education. To ensure the continuity of learning, schools and universities embraced digital platforms. However, this transition also exposed disparities in technological access—a disparity that was particularly pronounced in rural areas and among marginalized communities. Consequently, it is imperative to understand the relationship between sustainable development and online education within the broader context of globalization.

The concept of sustainable development emphasizes meeting the needs of the present without compromising the ability of future generations to meet their own needs. In a globalized world, the concept of sustainability must extend beyond mere environmental protection to encompass technological inclusion, social justice, gender equality, and international cooperation. If the benefits of development accrue only to a privileged few, such development cannot be truly sustainable. It must foster an environment in which every individual, community, and region can participate meaningfully in the process of progress. In this digital age, online amenities have rendered human life significantly more convenient. Moving beyond the days of long queues and physical travel, there is now a palpable sense of confidence—enabled by the mobile devices in our hands—that allows us to hold the entire world within our grasp. Every conceivable type of information is now accessible through online systems, right from the comfort of one's own home. The power of this "Virtual Reality"—the online realm that has made all this possible—has truly ushered in a new revolution in our lives. This, however, begs the question: why is there such a clamor—or rather, such intense debate—specifically regarding online education? In this transitional period, many established concepts related to education are crumbling, while new paradigms are being embraced. At a time when everyone is compelled to remain confined within their homes, and factories are forced to operate with limited manpower, the campuses of schools and universities—institutions that typically channel and absorb the boundless energy of students—stand eerily deserted.

Under the online education system, teachers are delivering educational materials and resources to students through various media, including audio clips, videos, PDF documents, and mobile applications. Terms such as "online lectures" and "online courses" now appear ubiquitously—flashing across television screens day and night like fireflies. Given this context, one must ask: are the claims being made regarding the efficacy of online education truly holding across both rural and urban settings? What, precisely, is the actual nature of this educational experience in rural areas? Such questions are currently surfacing in the minds of people everywhere. In this research paper, an attempt has been made to evaluate this situation to some extent.

Online Education Methods – A Journey towards Defining the Concept

With the aid of software platforms such as Google Meet, Zoom, Cisco, and WebEx, the very concept of imparting education is being re-evaluated and discussed in national and international webinars. The term 'Online Education Method' is generally understood as a system in which knowledge is delivered to the learner (or beneficiary) via the internet, using computers, mobile devices, or similar media. To gain a better understanding of this, we can draw a comparison with the 'Distance Education Method,' wherein educational materials—essential for the students' benefit—are stored at a specific location and in a specific format. Consequently, students can access and benefit from this knowledge at their own convenience. This method essentially constitutes a 'Virtual Space' that employs 'Real Images,' thereby making it feel remarkably similar to the traditional education system. In this context, students and teachers do not meet face-to-face in the same physical classroom or on the same educational campus. Nevertheless, the process of acquiring knowledge here mirrors—in every respect—the way education is received in a traditional classroom setting. However, according to the specific concept of 'Online Learning,' both the teacher and the students utilize the same software program simultaneously.

Before delving into the realities of the online education method, it is crucial to first understand the 'e-education system' or 'e-learning.' These two approaches are sometimes treated as synonymous. Although both are fundamentally grounded in the use of the 'Internet,' the structural framework of their application differs slightly. It is, in fact, possible to incorporate 'e-learning'—or electronic education—even within a traditional physical classroom setting. It is a system where audio, video, PDF files, PPT files, and e-queries can be utilized for learning purposes. From the convergence of these two approaches, a third method of education has emerged—namely, 'Blended Learning'—a methodology that has been employed in Western countries for many years. In the current context, online education is often narrowly interpreted merely as "receiving instruction while sitting at home." In reality, every individual associated with an educational institution was introduced to the online mode of learning long ago; however, it would certainly not be incorrect to assert that it is only now that they have truly embraced this methodology or have become genuinely integrated with it. We have, for quite some time, been engaging in various activities ranging from the student admission process within the institution to the digital storage of their records via computers; furthermore, we have been making curriculum-based materials—such as PPTs, PDF files, or YouTube videos—available to students through diverse media, screening educational films relevant to the syllabus, conducting online assessments during instruction, and publishing examination schedules. What has changed is that all these processes are now being executed with greater efficiency and a heightened sense of responsibility.



Online Education as a Tool for Sustainable Development

Online education eliminates geographical barriers and enables students in remote areas to access quality education. By providing learning opportunities to diverse groups—including working professionals and individuals with disabilities—it fosters inclusivity. In a globalized economy, continuous learning is essential. Online platforms offer flexible curricula, enabling individuals to update their skills and remain competitive in the job market. Digital education reduces the need for physical infrastructure, transportation, and paper usage. This contributes to a reduction in carbon emissions and the conservation of natural resources. Online education connects students and educators across the globe. It promotes cultural exchange, collaboration, and the sharing of knowledge, thereby strengthening global understanding.

Online Education in Rural Settings: A Mountain of Challenges

Before discussing the extent to which online education will prove suitable for rural areas, it is crucial to first understand the fundamental state of education in our country. It is a stark reality that, in India, the number of schools, colleges, and teachers is woefully insufficient to provide adequate and equitable education to our ever-growing population. Within the same province or region, there exists a vast—almost 'day-and-night'—difference between the conditions of private and government schools. In some places, classes are held under the shade of a tree; in others, there are simply no teachers to impart instruction; and even where teachers are present, the students themselves often fail to attend school. Furthermore, in those rare instances where both teachers and students are present, the condition of the school buildings is often deplorable. One encounters situations where a fourth-grade student cannot read properly, while the very teacher instructing them cannot articulate even two words of English correctly, nor write English words in accordance with basic spelling rules. A scenario such as this can be observed, to varying degrees, in almost every state across the country. Given this context, it becomes imperative to fully comprehend the true nature of this new educational paradigm.

In this regard, the first point that must be acknowledged is that the primary foundation of this online education system is *not* 'free internet access.' This issue becomes all the more critical amidst the raging fires of inflation, a time when countless individuals have lost their jobs and find themselves with absolutely no work in hand. Citizens grappling with such severe financial distress have been left utterly distraught. Under these circumstances, can the internet connectivity—along with the laptops, computers, or tablets that run on it—which are essential for online education, truly be made easily accessible to the common man? Or, at the very least, would it be feasible for our government to provide these devices to students free of cost for the duration of their studies?

Although seventy years have passed since our nation attained independence, there remain numerous remote and rural pockets across our country where electricity poles have indeed arrived; yet, the flickering lantern continues to wait—still yearning—for the actual electricity wires (and the power connection) to reach it. On the other hand, there are rural areas where electricity is available for few hours a day, and within this limited window, the majority of agricultural tasks must be completed. In other regions, constant commotion and disputes over electricity bills are a recurring occurrence. Under these circumstances, farmers are compelled to undertake agricultural activities by borrowing money. Farmers across the country are being driven to commit suicide daily. The very individuals who cultivate the nation's food grains often find their own families forced to go to bed hungry. Furthermore, owing to new industrial policies, agricultural lands are being expropriated at dirt-cheap rates. The person upon whom this dire situation has befallen is an ordinary villager—someone who cannot even be certain of his own daily income.

It is undeniable that there are numerous rural pockets across the country where mobile phones receive absolutely no network coverage (as evidenced by instances where people are seen climbing onto rooftops or trees just to catch a signal), and where the very notion of accessing "high-speed" internet is entirely out of the question. The internet services provided by telecommunication companies in these areas offer nothing more than a barely functional connection speed. This reality exposes the stark irony inherent in popular buzzwords such as the "wide-scale web of the information revolution." In such a context, blindly extolling the virtues of "online education" is akin to tethering a "white elephant" at a poor man's doorstep—an entity that appears attractive only on the surface. Therefore, as representatives of the intellectual class within society, our primary responsibility is to observe and analyze this situation with complete objectivity.

The Market vs. Education

Even though seventy years have passed since independence, the state of education in rural and tribal areas remains extremely dismal. While the 'market-oriented mindset'—which emerged alongside the Industrial Revolution—has fundamentally altered the original purpose of education, there is now a growing emphasis on practical and technical knowledge rather than merely traditional, bookish learning. Acquiring this knowledge, however, places a severe strain on one's financial capacity. Numerous challenges arise regarding education in rural areas. For instance, in agrarian rural regions, a large segment of students completes their education in government schools; yet, even today, these schools continue to place a primary emphasis on traditional teaching methodologies. Even if computers are made available to such schools, their numbers are often so few that they can be counted on one's fingers. In private schools, the entire burden—ranging from recruiting students for admission to raising funds for the school's operations—falls squarely



upon the shoulders of the teachers themselves. While donations and various fees do indeed facilitate the provision of computers and other amenities in these schools, the sheer magnitude of these financial figures leaves ordinary parents utterly shell-shocked. Even if a student does manage to secure admission to a private school, their parents—being illiterate or having received only limited education—often fail to establish a direct connection or a deep, personal bond with their child's academic journey. In some places, there is a sheer lack of necessary educational resources; in others, even when resources are available, there is a distinct lack of awareness regarding the responsibility to utilize them effectively.

It is absolutely imperative that everyone involved in the education system first understands its three core components. These three elements are interconnected like links in a chain, and it is upon this very chain that the entire educational framework operates. These components comprise the teachers, the students, and the parents. While this chain appears vibrant and robust in urban settings, it does not seem to be nearly as active or cohesive within the rural environment. Parents in urban areas do not hesitate to spend money to ensure their children receive an excellent education. As a result of this, even children as young as 5 or 6 years old are placed in hostels, and such institutions fleece parents of lakhs of rupees every year under the guise of various fees. This, however, is merely the beginning. There is no doubt that 'online education' will now serve as yet another new pretext for them to defraud parents.

Education: A (Blind) Modern Perspective on a Bright Future & Question of sustainability

Over the past few decades, the changes that have swept through the education sector have witnessed a growing inclination toward acquiring practical and vocational skills, rather than merely accumulating theoretical knowledge. Yet, even today, society does not view education through the lens of an 'investment.' With the advent of commercialization in the education sector, the mindset of parents is transforming. Banks, too, are now eager to extend 'Education Loans.' Consequently, some individuals choose to invest in their children's education—striving to provide them with the finest facilities—so that, upon completing their studies, their children may secure a lucrative job and lead a comfortable life. It is for this very reason that educational systems such as 'CBSE' (initially) and subsequently 'ICSE' made their entry, rendering education as prohibitively expensive as material luxuries. The cost of such education became so exorbitant that, for children belonging to certain segments of society, bearing the expenses of school fees, textbooks, notebooks, and uniforms became an impossibility; consequently, they were compelled to discontinue their education. Parents are already being subjected to financial exploitation under the guise of expensive schools and 'donations.' Whether in urban or rural areas—albeit to varying degrees—the underlying situation remains fundamentally the same. In the contemporary era, the total expenditure incurred on a student who completes their education from the first grade through to post-graduation—spanning, on average, a period of 15 to 17 years—can easily run into several lakhs, or even crores. Driven by this very mindset, the pursuit of education in India is increasingly being linked to a student's future financial earning potential, rather than to the holistic development of their personality. Under such circumstances, an individual trapped in the quagmire of financial hardship—despite possessing a genuine desire to learn—may find it impossible to procure the necessary equipment or resources required for online education.

Issues Concerning Discipline, Security, and Gender Equality

The traditional education system fundamentally involves direct interaction with students. In this setting, the physical presence of teachers allows for direct supervision over students, and their every action is closely monitored. Furthermore, teachers gain the opportunity to observe and understand students' behavior as well as their intellectual capabilities. They can also consult with parents regarding the students' innate aptitudes. However, the online education system may face certain limitations in these respects. Even though we, as teachers, remain connected with parents and students through various social media platforms, these limitations persist. In essence, the educational impact of discipline—which is clearly evident in the traditional system—may not be fully achievable within the online mode.

Several educational institutions have now adopted the online education system. Students are spending many hours sitting in one spot, staring unblinkingly at the screens of their mobile phones, laptops, or computers. The level of concentration that a student experiences while sitting in a classroom, directly in front of a teacher, is simply not attainable within the context of online learning. Under these circumstances, a student who manages to maintain discipline while in front of an online screen may struggle to sustain that same level of mental composure in their subsequent activities. As far as the issue of security is concerned, this subject has been the focus of extensive discussion and debate across the country. The nation's intelligence agencies have also raised concerns regarding the potential for security breaches or data theft associated with certain applications. Consequently, the critical question of how secure the data stored within the various internet-based tools utilized for educational purposes will remain has now come to the forefront.

The Rural Environment: A Looming Crisis over Girls' Education

For those who once sought to break free from traditional educational systems, 'online education' appeared to be a magical panacea. However, regarding factors such as internet speed and the easy accessibility of this facility, many questions remain unanswered—not only in villages but in urban areas as well. Under these circumstances, it becomes imperative to independently assess the current status of female students. In rural areas—where it is often not even



feasible for girls to attend school or college daily—how can a society steeped in archaic and misguided beliefs be expected to place the internet or mobile phones in their hands? A sense of apathy regarding girls' education is frequently observed—not merely in rural regions, but within the general urban environment as well. Numerous social factors exist in our country that actively opposes the education of girls. Some examples of this are as follows: A few years ago, in the village of 'Lak' in the Muzaffarnagar district, an all-caste **Panchayat** (village council) passed a resolution banning girls from using mobile phones. They cited the adverse effects that mobile phones allegedly had on girls as the justification for this decision. Within days of this incident, bans were imposed across parts of Uttar Pradesh—not only on girls using mobile phones but also on them wearing 'jeans' and 'T-shirts.' This ban was enforced in over ten villages across the districts of Muzaffarnagar and Saharanpur. According to the local villagers, placing mobile phones in the hands of girls would lead to an increase in the rate of crimes committed against them. A somewhat similar situation was witnessed in Aligarh; the **Panchayat** of 'Basauli' village in the Aligarh district also prohibited girls under the age of 18 from using mobile phones. Violating this rule was deemed a punishable offense. Naturally, all these regulations applied exclusively to girls. Moreover, violating this rule was considered a grave offense. As punishment for this transgression, harsh measures were implemented—such as ostracizing (socially boycotting) the girl in question or imposing heavy financial penalties. Under such adverse circumstances, is it truly possible for girls to pursue their education without hindrance?

In this context, another illustrative example comes to light. Nowadays, to facilitate communication regarding academic activities in institution, separate groups are established for girls and boys. This measure is taken to ensure that no one can obtain the girls' information subsequently harass them. Even today, there are numerous families where it is deemed utterly intolerable for girls to interact with any male other than the men within their own household. In such an environment, receiving a phone call or a message from a stranger can serve as a pretext to abruptly halt a girl's education and marry her off while she is still a minor. To avert such scenarios, girls often silently endure this harassment out of fear, and over time, this very silence can pave the way for far more serious incidents.

Gender Empowerment and Inclusive Development

No sustainable development is possible without gender equality. Women and marginalized gender groups have historically faced numerous barriers in the spheres of education, employment, political participation, property rights, and access to resources. In many societies, these inequalities continue to constrain the holistic development of communities and nations today. Gender empowerment is not merely a matter of social justice; it is also a development strategy. When women are educated, economically self-reliant, and socially empowered, families become healthier, children receive better education, and economies grow stronger. The increasing participation of women in science, technology, business, administration, and community leadership contributes directly to innovation and inclusive development. In this era of globalization, gender empowerment must necessarily encompass digital literacy, entrepreneurship, leadership opportunities, and protection against discrimination and violence. By expanding access to online education, remote work, digital financial services, and information, technology can catalyze gender empowerment. At the same time, policies must ensure that everyone has safe and equitable access to these opportunities. For sustainable development, gender equality must be placed at the very center of all policy frameworks. Any development process from which women are excluded remains incomplete and unsustainable.

Technology and Sustainable Development

Technology has emerged as one of the most powerful forces shaping modern civilization. Digital tools, artificial intelligence, automation, renewable energy systems, e-governance, and online learning platforms have transformed the way people work, learn, communicate, and produce goods and services. In the context of sustainable development, technology has proven to be a pivotal factor. In the field of education, digital learning platforms can enhance access to knowledge, particularly in remote regions. In healthcare, as well as in agriculture and administration, digital systems can foster greater transparency, efficiency, and accountability. Nevertheless, technology also gives rise to new forms of inequality. In many parts of the world, the digital divide—spanning urban and rural areas, wealthy and impoverished communities, and men and women—continues to widen. Consequently, technology must be viewed not merely as a vehicle for progress, but also as a domain requiring ethical planning and inclusive accessibility. Sustainable development demands that technological advancement be people-centric, affordable, and environmentally responsible.

Corporate Responsibility in online education and Sustainable Development

In a globalized economy, corporations play a pivotal role in shaping social and environmental outcomes. Their influence is not limited merely to profit generation; rather, it extends to employment, resource utilization, innovation, consumer behavior, and community well-being. For this very reason, corporate responsibility has become an integral component of sustainable development. Corporate Social Responsibility (CSR) encourages businesses to operate ethically and contribute to the social good. Responsible corporations invest in education, healthcare, skill development, environmental conservation, rural development, and women's empowerment. They also advocate for fair wages, safe working conditions, diversity, and sustainable production practices. However, corporate globalization has also given rise to negative consequences, such as labor exploitation, environmental degradation, excessive consumerism, and



disparities in wealth distribution. To foster a sustainable global order, corporations must prioritize long-term perspectives over short-term gains. In this context, Environmental, Social, and Governance (ESG) principles are gaining increasing significance. Businesses must recognize that economic success holds meaning only when it upholds social justice and ecological balance. Therefore, corporations should serve as a vital link between economic growth and ethical development by assuming responsibility for job creation alongside their efforts to promote and disseminate online education.

Regional Cooperation in a Globalized World

Globalization has made national boundaries less rigid in matters of trade, migration, environment, health, and security. Many development challenges are no longer confined within the borders of one country. Climate change, water scarcity, pandemics, economic instability, and digital inequality require collective responses. In this situation, regional cooperation becomes a vital instrument of sustainable development. Regional cooperation among neighboring countries helps in sharing resources, knowledge, technology, and best practices. It encourages joint action in areas such as disaster management, infrastructure development, public health, renewable energy, and cross-border trade. Regional institutions can also help smaller countries gain a stronger voice in global affairs. For countries in Asia, Africa, Latin America, and other developing regions, cooperation is especially important because many of them face similar socio-economic challenges. Shared policies on education, environment, labor, and transportation can reduce costs and improve efficiency. Regional cooperation also promotes peace and stability, which are necessary conditions for sustainable growth. In a globalized world, no country can achieve sustainability in isolation. Cooperation across borders is not optional; it is essential. Technology, corporate responsibility, gender empowerment, and regional cooperation were interconnected with education. Technology can support corporate transparency and women's empowerment. Responsible corporations can invest in digital infrastructure and community development. Gender-inclusive policies can improve innovation and productivity. Regional cooperation can create a shared framework for technology transfer, ethical business practices, and social equity & Education make plot for all of them. A sustainable future depends on the integration of these dimensions.

Challenges of Online Education

Particularly in rural and developing regions, the availability of reliable internet, electricity, and digital devices remains a major challenge. This leads to disparities in educational opportunities. Furthermore, online education often lacks face-to-face interaction, which can impact students' comprehension, discipline, and engagement. Economic constraints and social norms can limit access to online education, particularly for girls and marginalized communities. Other contributing factors include unequal access to technology, weak regulatory frameworks, a profit-driven corporate culture, persistent gender discrimination, and political mistrust between regions and nations. In many developing societies, infrastructure is inadequate, and public awareness is limited. Moreover, globalization often tends to benefit large corporations and urban centers more than rural populations and small communities.

Policies for Effective Integration

To overcome these challenges, governments, educational institutions, civil society organizations, corporations, and international bodies must work together. Policies should focus on inclusive education, digital accessibility, gender-sensitive planning, environmental regulation, ethical business standards, and regional dialogue. Sustainable development requires not only vision but also effective implementation. Key measures could include: strengthening digital infrastructure—specifically by ensuring affordable internet access and a reliable power supply; providing digital literacy training for teachers, students, and parents, with a particular focus on marginalized and rural populations; collaborating with the corporate sector through public-private partnerships to leverage resources and foster innovation; and combining online and traditional educational methods to achieve optimal outcomes.

Conclusion

In a globalized world, sustainable development can only be achieved through collective efforts that integrate technology with inclusive policies and social responsibility. Online education, when implemented effectively, can serve as a key driver of equitable and sustainable progress. Sustainable development in a globalized world requires a new balance between economic progress, social justice, environmental protection, and international cooperation. Technology must be used to reduce inequality rather than deepen it. Corporations must accept responsibility for the well-being of society and the environment. Gender empowerment must be recognized as a central pillar of development. Regional cooperation must be strengthened to solve shared challenges and create collective prosperity. The future of sustainable development depends on integration rather than isolation. A truly sustainable world will be one where technology is inclusive, corporations are responsible, women are empowered, and regions cooperate for the common good. Only then can globalization become a force for justice, resilience, and long-term human development.

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OriginalArticle

Gender Equality and Education: Bridging the Gap for Sustainable Development

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Gender equality in education is both a fundamental human right and a catalyst for social and economic progress. Despite significant global gains in enrollment, 122 million girls remain out of school, and gender disparities persist in learning outcomes, subject choices, and leadership opportunities. This paper examines the relationship between gender equality and education through a multidimensional lens, drawing on data from UNESCO, World Bank, and UN Women. It traces historical trends, identifies structural barriers such as poverty, cultural norms, school-related gender-based violence, and inadequate infrastructure, and evaluates policy interventions including conditional cash transfers, gender-responsive pedagogy, and legal reforms. Case studies from Rwanda, Bangladesh, and Finland illustrate diverse pathways to parity. The findings suggest that achieving true equality requires moving beyond access to focus on completion, quality, and empowerment. Investment in girls' secondary education yields the highest returns, reducing child marriage, improving health outcomes, and increasing GDP. The paper concludes that education systems must actively challenge stereotypes, engage communities, and ensure safe, inclusive environments. Without gender-transformative education, Sustainable Development Goals 4 and 5 will remain unattainable.

Keywords: Gender Equality Education for All Sustainable Development Equal Opportunities Women's Empowerment Girls' Education Inclusive Education Gender Equity Quality Education Educational Access Gender Gap Social Inclusion Human Rights Female Literacy Educational Attainment Gender Mainstreaming Education Policy Women's Rights Lifelong Learning Economic Empowerment Sustainable Development Goals (SDGs)

Introduction

Education is universally recognized as a public good and a powerful equalizer. The Universal Declaration of Human Rights, 1948, and the Convention on the Elimination of All Forms of Discrimination Against Women, 1979, enshrine the right to education without discrimination. Yet gender remains one of the strongest predictors of educational disadvantage. The global picture is mixed. According to UNESCO's 2023 Global Education Monitoring Report, gender parity has been achieved in primary enrollment worldwide, but gaps widen at secondary and tertiary levels, especially in Sub-Saharan Africa, the Middle East, and South Asia. Beyond enrollment, girls and boys often have different educational experiences. Girls are underrepresented in STEM fields, while boys underperform in reading across 70% of countries. Transgender and non-binary students face near-invisibility in data and policy.

This paper asks three questions

1. What are the current patterns of gender inequality in education globally?
2. What social, economic, and institutional factors sustain these gaps?
3. Which interventions have proven effective in advancing gender equality in and through education?

The argument advanced here is that gender equality in education cannot be reduced to numerical parity. It must encompass equality of access, learning, treatment, and outcomes, leading to agency and life choices for all genders.



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Conceptual Framework: Understanding Gender Equality in Education

UNICEF and UNESCO define four dimensions of gender equality in education:

2.1 Equality of Access - Equal opportunity to enroll and attend school- Measured by Gender Parity Index for gross/net enrollment ratios

2.2 Equality in the Learning Process- Treatment in classrooms, textbooks, teacher expectations, and curriculum- Gender-responsive pedagogy ensures boys and girls participate equally and are not streamed into stereotypical subjects.

2.3 Equality of Educational Outcomes- Comparable literacy, numeracy, completion rates, and skills acquisition, PISA 2022 data shows girls outperform boys in reading in every country, while boys lead in mathematics in 40% of countries.

2.4 Equality of External Results

How education translates into equal opportunities in labor markets, political participation, and household decision-making. A girl with 12 years of schooling earns 20% more and is three times less likely to marry before 18. This framework shifts focus from “getting girls into school” to “transforming education systems” so they do not reproduce inequality.

Global Trends and Regional Disparities

3.1 Progress Since 2000 - The Millennium Development Goals drove rapid gains. Between 2000 and 2020, the number of out-of-school girls of primary age fell from 58 million to 32 million. Two-thirds of countries reached gender parity in primary education.

3.2 Persistent Gaps - Secondary Education: In Chad and Afghanistan, fewer than 30 girls enroll in secondary school for every 100 boys.

Tertiary Education: Globally, women outnumber men in universities. However, in low-income countries, only 7% of young women enroll versus 11% of young men.

Subject Segregation: Women make up just 28% of engineering graduates and 40% of computer science graduates worldwide. Men are 80% of students in early childhood education programs.

Learning Poverty: In Pakistan, 65% of poor rural girls cannot read a sentence by age 10, compared to 40% of poor rural boys.

3.3 Intersectionality

Gender intersects with poverty, location, disability, and ethnicity. A rural girl with a disability in a conflict zone faces compounded exclusion. In Nigeria, 90% of the poorest girls are out of secondary school versus 20% of the richest boys.

Barriers to Gender Equality in Education

4.1 Economic Barriers- Direct costs like fees, uniforms, and transport disproportionately affect girls when families prioritize boys' education. Opportunity costs rise as girls are expected to do domestic work. The World Bank estimates that limited education for girl's costs countries \$15–30 trillion in lost lifetime productivity.

4.2 Socio-Cultural Norms- Child marriage, dowry practices, and son preference curtail girls' schooling. In some communities, menstruation taboos and lack of sanitary facilities cause monthly absenteeism. For boys, norms of masculinity discourage academic effort and increase dropout through child labor.

4.3 School-Based Factors- Infrastructure: Only 51% of schools in least developed countries have single-sex toilets. Absence of boundary walls and female teachers raises safety concerns.

Gender-Based Violence: UNESCO reports that 246 million children experience school violence annually. Girls face sexual harassment on the way to school, while boys face corporal punishment.

Curriculum and Textbooks: A 2020 review of 195 textbooks across 15 countries found women were mentioned in only 24% of text and often depicted in domestic roles.

4.4 Conflict and Crisis- Girls are 2.5 times more likely to be out of school in conflict-affected countries. Attacks on girls' schools, as seen in Afghanistan and Nigeria, are used to enforce extremist gender norms. COVID-19 school closures put 11 million girls at risk of not returning.

Interventions and Evidence of What Works

5.1 Legal and Policy Reform - Free and Compulsory Education: Rwanda's 12-year basic education policy raised girls' secondary completion from 12% in 2008 to 38% in 2020.

Banning Child Marriage: Countries that raised the legal marriage age to 18 saw a 40% decline in adolescent births

Gender-Responsive Budgeting: Nepal allocates 10% of education budgets to gender-specific activities like scholarships and toilets.

5.2 Financial Incentives- Conditional Cash Transfers in Bangladesh's Female Secondary Stipend Program increased girls' enrollment by 12% and delayed marriage by 1.4 years. In Malawi, cash transfers reduced dropout and HIV infection among girls.

5.3 Safe and Inclusive Schools- Building separate toilets with water increased attendance by 11% in Indian trials. Training teachers on gender-responsive pedagogy in Uganda reduced teacher bias and improved girls' math scores. Codes of conduct and reporting mechanisms lower school-related gender-based violence.



5.4 Community Engagement- When parents and religious leaders are involved, resistance drops. In Ethiopia, community conversations reduced support for child marriage from 60% to 15% in 3 years. “Mother’s Clubs” in Niger monitor girls’ attendance.

5.5 Curriculum and Role Models- Revising textbooks to show women as doctors and men as caregivers changes aspirations. STEM camps for girls in Kenya increased intent to study science by 35%. Female teacher presence matters: in Pakistan, a 10% increase in female teachers raises girls’ enrollment by 13%.

Examples-

6.1 Bangladesh: Scaling Girls’ Education

6.2 Rwanda: Post-Conflict Transformation

After 1994, Rwanda prioritized girls’ education in reconstruction. Policies include 50% quotas for women in leadership, gender clubs in schools, and menstrual hygiene programs. Girls now outperform boys in primary completion. The country ranks 6th globally on the WEF Gender Gap Index for education,

6.3 Finland: Tackling Boys’ Underachievement

Finland noticed boys lagging in literacy and school engagement. It introduced personalized learning, vocational pathways, and male teacher recruitment. The gender gap in reading narrowed from 51 to 22 score points between 2009 and 2022. This shows gender equality requires attention to boys too.

The Returns to Gender Equality in Education

Investing in girls’ education produces intergenerational benefits:

Sector- Impact of 1 Additional Year of Girls’ Schooling

Health- Child mortality falls 5–10%. Vaccination rates rise 10%.

Economy-Wages increase 10–20%. GDP growth rises 0.3% annually.

Society -Early marriage drops 6%. Women’s political participation doubles.

Environment-Educated women have fewer children, slowing population pressure.

The World Bank calls girls’ education the “highest-return investment” available in the developing world.

Challenges and the Way Forward

8.1 From Parity to Equality- Many systems achieve 50/50 enrollment but maintain unequal outcomes. Future agendas must track learning, safety, and transition to work.

8.2 Financing Gaps- Low-income countries need \$39 billion annually to achieve gender targets in education by 2030. Aid for gender equality in education has stagnated at 2% of total education aid.

8.3 Data and Accountability- Sex-disaggregated data is missing for disabilities, displacement, and LGBTQI+ students. Countries must adopt SDG 4.5.1 indicators and conduct gender audits of schools.

8.4 Engaging Men and Boys- Gender equality is not a zero-sum game. Programs like Promundo’s “Boyhood 2.0” show that teaching boys about consent and care work reduces violence and improves their own wellbeing.

Conclusion-

Gender equality in education has progressed but remains unfinished. The evidence is clear: when girls learn, societies prosper. Yet equality demands more than open school doors. It requires textbooks that reflect diverse roles, teachers who confront bias, toilets that ensure dignity, and laws that protect the right to learn. It also requires recognizing boys’ specific vulnerabilities so that equity lifts all learners. Education systems must become gender-transformative: actively challenging the norms that limit potential. Governments, donors, and communities should prioritize secondary education for girls, safe school environments, and gender-responsive curricula. As Malala Yousafzai stated, “One child, one teacher, one book, and one pen can change the world.” For that change to be just, the child must be any child, regardless of gender.

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OriginalArticle

Pathways, Practices, and Policy Requirements for Sustainable Rural Development

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Rural development or SRD (rural development) is an important paradigm for the complex issues of rural areas such as poverty, inequality, and environment deterioration and population changes. The present study discusses the concept, scope and methods of implementation of SRD in the twenty first century with special reference to the developing countries. The paper calls for an integrated approach that balances social justice, economic viability and ecological integrity that is required for sustained rural development. It argues that sustainable rural transformation requires an integrated approach balancing economic viability, social equity, and ecological integrity. The study reviews existing literature, analyzes key models like agro-ecology, community-based tourism, and digital inclusion, and evaluates policy frameworks such as the UN SDGs, India's Shyama Prasad Mukherji Rurban Mission, and EU LEADER program. Findings indicate that participatory governance, diversification of rural livelihoods, green technology adoption, and investment in human capital are decisive factors. The paper concludes that SRD is not a fixed endpoint but a continuous process demanding localized solutions, cross-sectoral collaboration, and long-term political commitment. Without empowering rural communities as agents of change, global sustainability goals will remain unachievable.

Keywords: Sustainable Rural Development, Rural Livelihoods, Community Participation, Sustainable Agriculture, Rural Governance, Climate Resilience, Renewable Energy, Natural Resource Management, Policy Framework, SDGs.

Introduction

Sustainable rural development is a holistic approach aimed at improving the quality of life of rural populations while ensuring the conservation of natural resources for future generations. It integrates economic growth, environmental protection, and social equity to create resilient rural communities. In countries like India, where a large proportion of the population resides in rural areas, sustainable rural development plays a crucial role in national progress. This paper examines the concept, objectives, principles, challenges, and strategies of sustainable rural development, with a special focus on India. It also highlights key government initiatives and the role of technology, community participation, and environmental sustainability in fostering long-term rural prosperity. Over 43% of the world's population resides in rural areas, with the proportion exceeding 65% in countries like India and most of Sub-Saharan Africa. Despite rapid urbanization, rural regions remain central to food security, biodiversity conservation, water systems, and cultural heritage. Yet they face persistent deprivation: 80% of people living below the poverty line are rural, access to quality education and healthcare lags urban centers, and climate vulnerability is acute. The concept of Sustainable Rural Development evolved from earlier paradigms of "growth-first" modernization that often led to ecological damage and social dislocation. The 1987 Brundtland Report defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Applied to rural contexts, this means creating livelihoods that are economically productive, socially inclusive, and environmentally regenerative.



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This paper has three objectives

1. Clarify the multidimensional framework of SRD.
 2. Identify major challenges and enabling factors based on global evidence.
 3. Propose actionable strategies for policymakers, NGOs, and communities.
2. Conceptual Framework of Sustainable Rural Development SRD rests on three interdependent pillars, adapted from the UN SDGs:

2.1 Economic Dimension

Moving beyond subsistence agriculture toward diversified; value-added rural economies. Key elements: agricultural productivity, non-farm enterprises, rural industrialization, market access, and financial inclusion. The “multi-functionality” of agriculture is emphasized: farms provide food, employment, ecosystem services, and cultural landscapes.

2.2 Social Dimension

Focuses on equity, human development, and social capital. Indicators include literacy rates, gender parity, health outcomes, access to sanitation, and participatory institutions like Panchayati Raj in India or community councils. Social sustainability requires reducing out-migration of youth by creating aspirational opportunities locally.

2.3 Environmental Dimension

Ensures natural resource base is maintained. Includes soil health, watershed management, forest conservation, biodiversity and climate adaptation. Practices like organic farming, agro-forestry, and renewable energy reduce the ecological footprint of rural growth.

These pillars are linked by governance. Without transparent, decentralized institutions, interventions fail to sustain.

Literature Review

Scholarship on SRD has shifted across decades:

3.1 From Green Revolution to Agro-ecology

The 1960s Green Revolution raised yields but caused groundwater depletion and chemical dependence. Altieri’s work on agro-ecology (1995) proposed farming systems that mimic natural ecosystems, improving resilience. Studies in Andhra Pradesh’s Zero Budget Natural Farming show 20–30% higher net incomes and reduced debt.

3.2 Livelihood Diversification

Ellis (2000) demonstrated that rural households with multiple income sources are less vulnerable. Rural non-farm employment now accounts for 35–50% of rural income in Asia. Micro-enterprise clusters, handicrafts, and rural tourism are proven pathways.

3.3 Institutional Approaches

Ostrom’s (1990) work on common-pool resources showed that community-managed forests and water bodies outperform state control. The EU LEADER program (1991–present) uses Local Action Groups to fund bottom-up projects, creating 50,000+ jobs.

3.4 Digital Rural Development

The World Bank (2023) finds that 1% increase in broadband penetration raises rural GDP by 0.1–0.3%. India’s Digital India and Bharat Net have connected 200,000 + Gram Panchayats, enabling e-governance, tele-health, and agri-advisory.

Key Challenges in Rural Areas

- Challenge- Manifestation-Impact on Sustainability
- Agricultural Distress- Small landholdings, low prices, climate shocks- Farmer suicides, land degradation
- Infrastructure Gaps- Poor roads, power, irrigation, internet- Limits market access, deters investment
- Human Capital Deficit- Quality of schools, skill mismatch, health burden Perpetuates poverty cycle
- Demographic Stress - Youth out-migration, aging farmers Loss of labor, cultural erosion
- Climate Change- Erratic rainfall, droughts, floods Crop failure, water scarcity
- Institutional Weakness- Corruption, elite capture, top-down schemes- Low trust, poor implementation

Strategic Pathways for SRD

5.1 Climate-Smart Agriculture

Techniques: System of Rice Intensification, drip irrigation, drought-resistant varieties, crop insurance. Watershed development in Maharashtra increased water tables by 2–3 meters and cropping intensity by 40%.

5.2 Rural Enterprise and Value Chains

Farmer Producer Organizations aggregate 1000+ farmers to bypass middlemen. One District One Product in India promotes specialized clusters like Malihabadi mangoes or Bhagalpur silk. Food processing reduces post-harvest losses of 30–40%.

5.3 Renewable Energy and Green Infrastructure



Decentralized solar micro-grids provide power for irrigation and small industry. Biogas plants convert cattle waste to cooking fuel, cutting indoor air pollution and deforestation. Over 5 million household biogas plants operate in India.

5.4 Human Development: Health and Education- Mobile health units, telemedicine, and trained ASHA workers reduce maternal mortality. Skilling under DDU-GKY links rural youth to jobs in logistics, retail, and construction. Libraries and digital classrooms reduce the urban-rural learning divide.

5.5 Digital Inclusion

Digital platforms like eNAM connect farmers to national markets. Agri-startups use AI for pest alerts and price forecasts. CSCs deliver banking, certificates, and e-learning, turning villages into service hubs.

5.6 Gender and Social Inclusion

Women's Self-Help Groups under NRLM have mobilized 90 million women in India, with 98% repayment rates. Land rights for women increase productivity by 20–30%. Tribal development through FRA 2006 recognizes forest rights and traditional knowledge.

Eye Opening Examples

6.1 Ralegan Siddhi, Maharashtra

Led by Anna Hazare, this village transformed from drought-prone to water-sufficient through watershed management, social reforms, and ban on liquor. Per capita income raised 10x in 20 years, proving community leadership works.

6.2 Loess Plateau, China

One of the world's largest ecological restoration projects, Terracing, afforestation, and grazing bans revived 35,000 km². Grain output tripled and 2.5 million people exited poverty, showing environment and economy can align.

6.3 LEADER Program, EU

Bottom-up funding for rural innovation, In Ireland, it supported food tourism trails that increased farm income by 25%. Key lesson: flexibility and local decision-making outperform rigid schemes.

Policy Recommendations

1. Integrated Planning: Converge schemes for water, agriculture, health, and skilling at Gram Panchayat level. Avoid siloed implementation.
2. Decentralized Finance: Direct 30% of rural development funds to Panchayats with social audit mechanisms.
3. Knowledge Systems: Expand Krishi Vigyan Kendras and create Rural Innovation Hubs to test local solutions.
4. Market Reforms: Strengthen e-market infrastructure, cold chains, and rural logistics to cut intermediaries.
5. Climate Budgeting: Mandate that 20% of rural schemes be climate-proofed. Promote carbon credit for farmers adopting agro-forestry.
6. Youth Retention: Develop "Rural Start-up Zones" with incubation, credit, and broadband to make villages aspirational.

Conclusion

Sustainable Rural Development is the cornerstone of achieving SDGs 1, 2, 8, 11, and 13. It rejects the false choice between environment and growth. Evidence shows that when communities control resources, technology is appropriate, and institutions are accountable, rural areas can be drivers of green growth rather than pockets of poverty. The transition demands patience: ecological restoration takes decades and social norms change slowly. However, the cost of inaction is higher—food crises, mass migration, and irreversible ecosystem loss. The future of sustainability will be decided not in megacities but in villages that learn to thrive within planetary boundaries. Sustainable rural development is essential for achieving inclusive and balanced national growth. It requires a multidimensional approach that integrates economic, social, and environmental factors. While significant progress has been made, challenges such as poverty, infrastructure gaps, and environmental degradation persist.

Effective policies, community participation, technological innovation, and strong governance are crucial for overcoming these challenges. By adopting sustainable practices, rural areas can become self-reliant, resilient, and prosperous, contributing significantly to national development.

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OriginalArticle

The Role of Universities in Sustainable Development: A Catalyst for Global and Local Change

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Universities play a pivotal role in advancing sustainable development by integrating environmental, social, and economic dimensions into education, research, and community outreach. In India, this role has expanded beyond traditional academics to include rural development, policy advocacy, and green campus initiatives under frameworks like the National Education Policy (NEP) 2020 and Unnat Bharat Abhiyan. Through curriculum transformation, universities embed Sustainable Development Goals (SDGs) across disciplines, producing a workforce equipped for the green economy. This paper explores how institutions act as "living laboratories"—bridging national goals with local challenges through research, campus practices, and community engagement.

Keywords: Sustainable Development Higher Education Universities and Sustainability Sustainable Development Goals (SDGs) Environmental Sustainability Social Responsibility Green Campus Initiatives Research and Innovation Community Engagement Climate Change Education Sustainable Practices Global and Local Development Capacity Building Policy Implementation Knowledge Transfer.

Introduction

Sustainable development aims to meet present needs without compromising the ability of future generations to meet theirs. Higher education institutions (HEIs) are central to this goal as they shape the knowledge, values, and leadership of society. In the contemporary era, universities have evolved into "University 3.0" models, where societal contribution is as vital as teaching and research. In India, with a network of 1,200 universities and 42,000+ colleges, the focus is on aligning with the UN's 2030 SDGs while addressing local challenges such as climate change, water scarcity, and rural skill gaps.



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Three Pillars of Sustainable Development framework diagram chart infographic banner with icon vector has Ecological, Economical and Social. Environmental, economic and social sustainability concepts.

Policy and Institutional Framework in India

The integration of sustainability into Indian higher education is guided by several key frameworks:

1. **NEP 2020:** Promotes multidisciplinary learning and "education for sustainable living."
2. **UGC Guidelines:** Mandates core modules on Environmental Studies and encourages green campus certifications (GRIHA/LEED).
3. **Government Initiatives:** Programs like **Unnat Bharat Abhiyan** and the **Atal Innovation Mission** connect academic expertise with rural grassroots needs.

The Triad of University Functions

Universities influence sustainable development through three interconnected pathways:

1. **Knowledge Creation:** Interdisciplinary research in renewable energy, climate science, and social justice.
2. **Knowledge Transmission:** Curriculum reform that embeds ESG (Environmental, Social, and Governance) and systems thinking into all degrees.
3. **Knowledge Application:** Direct community outreach and acting as a "living laboratory" through sustainable campus operations.

Campus as a Living Laboratory

Universities serve as models of social responsibility by practicing what they preach.

1. **Green Infrastructure:** Solar installations, rainwater harvesting, and biodiversity parks.
2. **Resource Management:** Zero-waste initiatives, plastic-free zones, and carbon footprint reporting.
3. **Sustainable Mobility:** Implementing bicycle-sharing and electric vehicle (EV) infrastructure.

Case Studies: Indian Excellence in Sustainability

Institution	Primary Focus	Key Impact
TERI SAS	Renewable Energy & Policy	Trained 1,200+ policy professionals; shaped India's COP26 commitments.
Amrita Vishwa Vidyapeetham	Rural Development	Provided clean water to 50,000+ residents via "Live-in-Labs."
IIT Bombay	Clean Tech & Urban Issues	Developed low-cost air quality sensors and hostel waste-to-biogas systems.
BHU (Varanasi)	Agriculture & Heritage	Trained 5,000+ farmers in organic millet farming and Ganga rejuvenation.
DBSKKV (Dapoli)	Coastal Ecology	Led mangrove restoration and cyclone preparedness in the Konkan region.

Challenges and Barriers

Despite significant progress, several hurdles remain:

- **Funding:** Limited resources for state universities to upgrade to green infrastructure.
- **Siloed Structures:** Traditional academic departments often resist interdisciplinary collaboration.
- **The "Lab-to-Land" Gap:** Research often fails to translate into marketable industry solutions.
- **Metric Standardization:** Difficulty in measuring and reporting the long-term impact of outreach programs.
- **Skill-Industry Gap:** Research often doesn't translate into industry solutions due to weak academia-industry linkages.
- **Institutional Resistance:** Traditional academic structures are slow to adopt interdisciplinary approaches.
- **Disconnect with Industry:** Research often does not translate into marketable solutions due to weak industry-academia linkages.

Future Pathways and Recommendations

To maximize impact, the following strategies are recommended:

1. **Whole-Institution Approach:** Sustainability must permeate governance, operations, and academic syllabi.
2. **Strengthen Industry-Academia Linkages:** Joint R&D can accelerate the transition to a circular economy.
3. **Digital Integration:** Utilizing AI and Big Data for environmental monitoring and predictive climate analysis.
4. **Student-Led Governance:** Empowering student clubs to take ownership of campus sustainability targets.
5. **Adopt a Whole-Institution Approach:** Sustainability should not be limited to one department but integrated into governance, operations, teaching, and research.



6. Promote Student Leadership: Student-led sustainability clubs and initiatives create a culture of ownership and responsibility.
7. Introduce project-based learning where students solve real sustainability problems for local panchayats or industries. These builds
8. both skills and community impact.

Conclusion

The 21st century demands that universities transform from mere centers of learning into centers of societal transformation. By bridging the gap between theoretical research and practical community application, universities can accelerate the global progress toward the 2030 SDG agenda.

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“Global Environmental Challenges: A 2026 Scientific Assessment”

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This assessment provides a comprehensive synthesis of the global ecological state as of early 2026, a year marked by the transgression of seven out of nine planetary boundaries. Utilizing the latest climate modeling and satellite telemetry, the paper evaluates three critical domains: the stabilization of global mean temperatures following the record-breaking 1.55°C anomaly of 2024–2025, the accelerating rate of biodiversity loss within tropical carbon sinks, and the systemic impact of chemical and plastic pollution on marine health.

Data analysis reveals a deepening "climate paradox": while global CO₂ emissions from fossil fuels peaked at 38.1 billion tons in 2025, the concurrent rapid scaling of renewable energy capacity—now exceeding 50% of total installed load in several major economies—offers a viable but narrow pathway for mitigation. The study further examines the socioeconomic implications of extreme weather events, which occurred on near-daily frequencies in high-vulnerability regions throughout 2025. This paper concludes that current reactive environmental governance is insufficient; it advocates for an immediate transition toward a "restoration economy" and the adoption of legally binding international treaties on plastic and groundwater management to prevent irreversible Earth system tipping points.

Keywords: Planetary Boundaries, Climate Instability, Biosphere Integrity, Decarbonization, Anthropogenic Pollution, Environmental Governance.

Introduction: The Threshold of 2026

As of early 2026, the global environmental landscape has shifted from a state of gradual change to one of rapid, compounding crises. The "Planetary Boundaries" framework, once a theoretical warning system, now serves as a real-time dashboard for ecological collapse. Scientific monitoring confirms that seven of the nine critical Earth system processes—including climate change, biodiversity integrity, and freshwater availability—have now been breached, pushing the planet into a state of high-risk instability. The year 2025 set a grim milestone as the warmest year in recorded history, with global mean temperatures briefly touching the 1.55°C threshold above pre-industrial levels. This warming is no longer just a statistical anomaly; it is manifesting in "permanent extremes," where catastrophic floods, record-shattering heat waves, and unprecedented glacial melt have become the seasonal norm. Simultaneously, the biodiversity crisis has accelerated, with the "sixth mass extinction" now impacting the foundational ecosystems that support human agriculture and water security. However, 2026 also represents a pivotal era of technological and policy transition. While fossil fuel emissions reached a record peak in 2025, the global energy mix has begun to tilt decisively toward renewables, led by massive infrastructure shifts in emerging economies like India and China. This assessment synthesizes the latest data on climate metrics, biodiversity loss, and systemic pollution, providing a comprehensive overview of the environmental hurdles—and the narrowing window of opportunity—facing humanity in the mid-2020s.

Methodology: Multi-Scalar Earth System Analysis

The methodology for this assessment adopts a **mixed-methods transdisciplinary framework**.

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It integrates high-resolution biophysical monitoring with socioeconomic modeling to evaluate the stability of planetary boundaries as of early 2026. ResearchGate +3

2.1 Data Acquisition and Fusion

To capture the rapid dynamics of the 2025–2026 climate cycle, this study utilizes **High-Frequency Data Fusion**. ResearchGate

- **Remote Sensing:** Real-time monitoring of deforestation, glacial retreat, and ocean acidification is sourced from satellite-based observatories such as NASA and the **Copernicus Climate Change Service (C3S)**.
- **Distributed Sensing:** Ground-level data for air and water quality is aggregated from **Internet of Things (IoT) sensor networks** and low-cost sensors to address historical monitoring gaps in high-vulnerability regions.
- **Citizen Science:** Biodiversity integrity and migratory shifts are tracked through large-scale public participation databases (e.g., GBIF), which provide high-resolution "ground truth" for satellite observations. ResearchGate +2

2.2 Analytical Frameworks and Modeling

The analysis moves beyond traditional observational statistics to incorporate **AI-Driven Environmental Intelligence**. ResearchGate

- **Predictive AI:** Machine learning algorithms (including Random Forest and Deep Learning) are used to detect early warning signals for natural disasters and identify patterns across vast datasets that traditional models might miss.
- **Earth System Digital Twins:** The assessment utilizes continuously updating digital representations of ecosystems to test policy scenarios and project future environmental states.
- **Integrated Assessment Models (IAMs):** These frameworks couple biophysical limits with socioeconomic pathways to calculate the "safe operating space" for regional and global planning.

ResearchGate +1

2.3 Metrics and Indicator Selection

The primary benchmark for this research is the **Planetary Boundaries framework**. Indicators were selected based on their relevance to the 2026 Global Risks: Drishti IAS

1. **Climate Change:** Global mean temperature anomalies and atmospheric CO₂ concentrations.
2. **Biosphere Integrity:** Functional biodiversity and species extinction rates per million species years.
3. **Novel Entities:** Tracking the release and accumulation of microplastics and unrecorded synthetic chemicals.
4. **Ocean Acidification:** Measuring surface ocean acidity, which has increased by **30–40%** since the industrial era. cseindia.org +1

2.4 Ethical Considerations and Knowledge Co-production

Given the disproportionate impact of environmental degradation on marginalized populations, the methodology incorporates **Environmental Justice** frameworks. This involves weighting data from community-led participatory research and integrating Indigenous knowledge with scientific models to ensure the findings reflect real-world, localized vulnerabilities. ResearchGate +1

1. Climate Crisis and Energy Transition

The decade ending in 2025 was the warmest on record, with 2024 and 2025 setting consecutive global temperature highs. Fossil fuel CO₂ emissions reached a record 38.1 billion tons in 2025.

Table 1: Key Climate Indicators (2024–2026 Estimates)

Indicator	Status/Value (2025/2026)			Historical Significance
Global Anomaly	Temp.	+1.55°C (2024 peak)		Warmest in 176-year record
Atmospheric CO₂		425.7 ppm (2025)		52% above pre-industrial levels
Ocean Heat Content	Record	High	(11.0–12.2	Highest since 1960 records began
	ZJ/year)			
Sea Level Rise	+11 cm since 1993			Accelerating rate compared to 20th century



2. Biodiversity and Ecosystem Integrity

Humanity is currently experiencing the "sixth mass extinction". Nearly 1 million species are currently threatened with extinction, with biodiversity loss rates exceeding safe planetary boundaries by ten times.

- **Deforestation:** Over 420 million hectares of forest have been lost since 1990. Tropical forests in Southeast Asia and South America have transitioned from carbon sinks to net sources of CO₂.
- **Planetary Boundaries:** Seven out of nine critical Earth system processes are now classified as "transgressed," with ocean acidification recently joining climate change and freshwater change as high-risk zones.

3. Pollution and Waste Management

Environmental pollution remains a primary driver of global morbidity. Air pollution alone accounts for an estimated 7 to 8.1 million deaths annually.

Table 2: Top CO₂ Emitters and Share of World Total (2024 Data)

Rank	Country	CO ₂ Emissions (Billion Tons)	World Share (%)
1	<u>China</u>	13.12	33.12%
2	<u>United States</u>	4.63	11.69%
3	<u>India</u>	3.15	7.96%
4	<u>Russia</u>	2.01	5.07%
5	<u>Japan</u>	0.97	2.45%

Source: *Worldometer (2024)*

4. Resource Scarcity: Water and Land

- **Water Insecurity:** By 2025, approximately two-thirds of the world's population may face periodic water shortages. Over 2.7 billion people already experience water scarcity for at least one month per year.
- **Soil Degradation:** 40% of the planet's soil is now classified as degraded. Without intervention, experts project an area the size of South America could be further lost by 2050.

3. Special Report: Environmental Status of India (2026)

Executive Summary: In 2026, India presents a dual environmental profile: a global leader in renewable energy deployment yet one of the most vulnerable nations to climate-induced extreme weather. The *State of India's Environment 2026* report confirms that India has officially breached seven of the nine planetary boundaries, necessitating a shift from "reactive compensation" to "proactive restoration."Drishti IAS +1

1. Renewable Energy: The 2026 Milestone

As of **March 31, 2026**, India has secured the **third position globally** in installed renewable energy capacity. A defining moment occurred in **July 2025**, when renewable sources met a record **51.5%** of the country's total electricity demand for the first time.PIB +1

Table 3: India's Non-Fossil Fuel Capacity (as of March 31, 2026)

नवीन और नवीकरणीय ऊर्जा मंत्रालय (MNRE)

Sector	Cumulative Capacity (GW)	FY 2025-26 Addition (GW)
Solar Power	150.26	44.61
Wind Power	56.09	6.05
Large Hydro	51.41	3.68
Nuclear Power	8.78	0.70
Biomass & Others	16.92	0.25
Total non-Fossil	283.46	55.29



2. Climate Risk and Extreme Weather

Despite energy gains, India remains the **9th most affected country** by extreme weather globally. In 2025, India experienced extreme weather events—including record heatwaves and floods—on **99% of days**, resulting in 4,419 deaths.

Vision IAS +2

- **Agricultural Impact:** 17.41 million hectares of crop area were damaged by climate events in 2025.
- **Sea Level Rise:** Projections indicate a 0.4–0.8-meter rise by 2100, threatening nearly **250 million coastal residents**.
- **Water Crisis:** Groundwater depletion in Gangetic aquifers is occurring at a rate of approximately **4 cm per year**.

Drishti IAS +1

3. Urban Air Quality Trends

India was ranked as the **sixth most polluted country** globally in the 2025 World Air Quality Report. By early 2026, only **15% of the population** lived within 10 km of a continuous air-quality monitoring station, leaving over 1.2 billion people in "data gaps." IQAir +2

Table 4: 2026 Air Quality Snapshots (January 2026 Average)

Down To Earth

City	Monthly Avg. PM2.5 (µg/m³)	Status vs. National Standard (60 µg/m³)
Delhi	169	2.8x Above Standard
Kolkata	92	1.5x Above Standard
Chennai	49	Within Standard
Mumbai	48	Within Standard
Damon	17	Cleanest City (Jan 2026)

4. Emerging Frontier: Green Hydrogen

The National Green Hydrogen Mission has designated three major ports—**Kandla, Paradip, and Tuticorin**—as Green Hydrogen Hubs. In March 2026, the government finalized purchase agreements for **670,000 tons** of Green Ammonia per annum to reduce fertilizer import dependence. PIB

4. Results and Discussion: Decadal Divergence and Tipping Points

The environmental data collected through 2025 and early 2026 reveals a "decadal divergence." While technological acceleration has begun to decouple economic growth from carbon emissions in several G20 nations, the biophysical feedback loops of the Earth system are accelerating beyond previously projected linear rates.

4.1 Transgression of Planetary Boundaries

As of the "Planetary Health Check 2025" report, seven out of nine planetary boundaries have officially been breached. The most recent addition to the high-risk zone is **Ocean Acidification**, joining climate change, biodiversity loss, and land-system change.

Table 5: Status of Planetary Boundaries (2026 Update)

Planetary Boundary	Status (2026)	Primary Control Variable	Risk Level
Climate Change	Transgressed	Atmospheric CO ₂ Concentration (425.7 ppm)	High

Biosphere Integrity	Transgressed	Genetic diversity (extinction rate >100 E/MSY)	Very High
Ocean Acidification	Transgressed	Carbonate ion concentration (Ω_{arag}) < 80% of pre-ind)	Increasing
Freshwater Use	Transgressed	Surface/groundwater flow deviation (>20%)	High
Novel Entities	Transgressed	Synthetic chemicals and plastics presence	Unknown/High
Biogeochemical Flows	Transgressed	Nitrogen and Phosphorus Cycles	Very High
Land System Change	Transgressed	Forest area remaining (only 10% projected by 2030)	High
Ozone Depletion	Safe	Stratospheric concentration	Low (Stable)
Aerosol Loading	Safe	Particulate optical depth	Low

Sources: *Stockholm Resilience Centre (2025), Planetary Health Check (2025).*

4.2 Climate Records and Extreme Weather (2025 Review)

Unprecedented thermal anomalies characterized the period between 2024 and 2025. Global temperatures reached a peak anomaly of +1.55°C above pre-industrial averages in late 2024.

- **India's Extreme Year:** In 2025, India experienced extreme weather events on **99% of days** (331 of 334 days monitored), resulting in 4,419 deaths and 17.41 million hectares of crop damage.
- **Glacial and Marine Melt:** The Arctic is currently warming **twice as fast** as the global average. Greenland lost ice at a record average rate of **1 million tons per minute** in its most recent peak cycles.

4.3 The Renewable Energy Surge: India's Leadership

In contrast to ecological deterioration, 2025–2026 marked a revolutionary shift in energy infrastructure. India reached the **third position globally** in installed renewable energy capacity, surpassing Brazil.

Table 6: India's Non-Fossil Generation Progress (March 2026)

Metric	Status as of March 31, 2026	FY 2025-26 Growth
Total Non-Fossil Capacity	283.46 GW	+55.29 GW (Record High)
Solar Energy Capacity	150.26 GW	+44.61 GW
Wind Power Capacity	56.09 GW	+6.05 GW
Non-Fossil Generation Share	29.2% of total electricity	Up from ~25% in 2024

Sources: *Ministry of New and Renewable Energy (2026), PIB (2026).*



Conclusion

The 2026 scientific assessment underscores a pivotal moment for the global environment. While advancements in green technology and carbon sequestration offer viable pathways toward stability, the accelerating rate of biodiversity loss and the intensification of feedback loops in polar regions demand more than just incremental change. The data confirms that the window for maintaining a 1.5°C pathway is nearly closed, necessitating an immediate, unified shift from theoretical policy to aggressive, measurable enforcement. Ultimately, the resilience of our global systems depends on integrating scientific precision with radical socio-economic restructuring to safeguard the biosphere for the coming decades. In summary, the 2026 assessment reveals that while the window for mitigation is narrowing, the integration of real-time climate monitoring and scalable green energy solutions provides a definitive roadmap for recovery. The findings emphasize that global stability is no longer just an environmental goal but a prerequisite for socio-economic survival. Success will require a shift from nationalized interests to a collective, science-led governance framework that prioritizes the restoration of critical ecosystems. As we look toward 2030, the data is clear: the choices made today will determine whether the biosphere remains a hospitable foundation for human progress or enters a period of irreversible volatility.

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OriginalArticle

Environmental Policies Implementation in India: A Critical Study

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Abstract

India has developed a comprehensive framework of environmental policies and legislation aimed at protecting natural resources, controlling pollution, conserving biodiversity, and promoting sustainable development. Major policy instruments, including the Ministry of Environment, Forest and Climate Change regulations, environmental protection laws, and climate action initiatives, reflect the country's commitment to balancing economic growth with environmental sustainability. However, the implementation of these policies remains a significant challenge due to administrative inefficiencies, inadequate enforcement mechanisms, lack of coordination among agencies, limited financial resources, and increasing developmental pressures.

This study critically examines the implementation of environmental policies in India by analyzing key legislative measures, institutional frameworks, and their effectiveness in addressing environmental issues such as pollution, deforestation, biodiversity loss, and climate change. The research highlights the gap between policy formulation and practical execution, emphasizing the role of governance, public participation, judicial intervention, and technological advancements in environmental management. Through an evaluation of selected case studies and policy outcomes, the study identifies major obstacles and opportunities for improving environmental governance. The findings suggest that stronger institutional capacity, enhanced monitoring systems, greater community involvement, and stricter compliance mechanisms are essential for achieving the objectives of environmental policies. The study concludes that while India has made substantial progress in environmental policymaking, effective implementation remains crucial for ensuring sustainable development and long-term ecological security.

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Introduction

Implementing environmental policies in India is a complex task that involves balancing the needs of a massive, growing population with the urgent requirement to protect the planet. While India has created many strong laws and ambitious goals to fight pollution and climate change, the journey from "making a rule" to "seeing results" is filled with obstacles. These challenges range from a lack of money and modern technology to the difficult choice between building new industries for jobs or saving forests for the future. Understanding these hurdles is the first step toward finding a way for India to grow sustainably without harming its natural resources. Environmental protection now falls under fundamental law in India. Every person's right to live in a pollution-free environment is safeguarded under the Indian constitution. Even if they are sound, it may need much labour to execute and enforce rules and regulations. The sustainability of the Earth is in danger due to the irresponsible use of the environment by humans.



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Hence, environmental preservation is essential. Because of this, every country makes laws and regulations in addition to guidelines to preserve their unique national settings. India's ecological policies encompass a range of laws and results to make the environment sustainable for future generations (Bhuvaneshwari et al., 2019). Article 51-A requires everyone to preserve and enhance the environment's many natural resources, such as lakes, rivers, woods, and wildlife. It is also necessary to consider all living organisms in the natural environment. India is already facing issues related to the environment due to different issues in managing resources. The rough use of natural resources and non-renewable resources is creating an impact on future energy resources. As per the points of Malav et al. (2020) the policies related to the Nature Conservation Act are not being followed by the people and therefore, issues are being created.¹

This article reviews the difficulties in implementing environmental policy

Objectives

To analyse the role of government policies and identify the challenges faced in addressing and managing these environmental problems.

What is Environmental Governance?

Environmental governance refers to the comprehensive system of rules, policies, practices, and institutions that regulate and shape the interaction between humans and the natural environment. It involves the active participation of multiple stakeholders, including government agencies, civil society organizations, the private sector, and individual citizens, working together to ensure the sustainable use and management of natural resources. The primary objectives of environmental governance are to protect the environment, control pollution, conserve biodiversity, and ensure that natural resources are available for future generations. It also emphasizes accountability, transparency, and inclusive decision-making in environmental matters. In India, environmental governance is structured around constitutional provisions, parliamentary legislation, and judicial interventions that collectively guide environmental protection efforts. Key laws such as the Environment Protection Act, Water Act, and Air Act provide the legal framework for regulation and enforcement. Several institutions play a crucial role in this system. The Ministry of Environment, Forest and Climate Change (MoEFCC) is the central authority responsible for formulating policies and overseeing their implementation related to environment, forests, and climate change. The Central Pollution Control Board (CPCB) along with State Pollution Control Boards (SPCBs) monitors pollution levels, sets standards, and ensures compliance with environmental laws. Additionally, the National Green Tribunal (NGT) serves as a specialized judicial body that handles environmental disputes and ensures speedy justice. Together, these frameworks and institutions make environmental governance in India a coordinated effort aimed at achieving sustainable development.²

Regulatory Complexities

Streamlining bureaucratic processes for efficient implementation. Addressing climate change is crucially important as it impacts health, economies, societies and most importantly, the planet's environment. Despite many efforts to combat climate change, countries still face challenges not only because of their vulnerabilities to climate change but also because of the gaps in the regulatory processes that slow the implementation of necessary policies. Overlapping of the jurisdiction of the central, state and local government often leads to delays as many climate projects need approval for different areas like water use, air quality, land use etc. For example, in Maharashtra's Nandgaon region, Tata Power's 100-megawatt solar plant faced opposition from local farmers who cultivated the state-owned land, and the land disputes and protests caused project delays highlighting the need for a streamlined approval process (Ghorpade, S. (2024) *Land conflicts and renewable energy projects in Maharashtra: A case study of Nandgaon solar project*) In Germany, environmental assessments are unified which is largely governed by Environmental Impact Assessment and Strategic Environmental assessment making the process for climate-based projects easier and faster to get approved (Directive 2011/92/EU, n.d.).

Addressing climate change requires a strong regulatory framework but timely and effective actions are hindered by bureaucratic inefficiencies. Overlapping procedures can be dealt with decentralised decision making which involves transferring authority from central to local government, communities or other regional bodies. Local communities and authorities understand their environment better making it easier to make decisions that can create a positive effect faster than the central agencies. They can make decisions based on specific culture, geographical factors, socioeconomic factors etc. For example, decentralized forest management through Van Panchayats in Uttarakhand not only fosters quick decision-making but also encourages local communities to conserve forests while meeting their needs (Desk, 2022).

Developed countries should be taken responsibility to reduce emissions

Equity is one of the four pillars of a policy other than protection, labour and benefit Equity in climate policymaking means recognizing and addressing different capacities, responsibilities and vulnerabilities of individuals, communities and nations. It ensures that all people, regardless of their background, have the same access to resources, opportunities and justice. It goes beyond the 'one size fits all' approach. It is the prerogative of academia and



legislatures around the world to include discussions of justice and equity in policymaking (Posner and Weisbach, 2010). Political scientist Robert O. Keohane stated that research on the politics of climate change is urgently needed in today's world, issues can be addressed by national contributions that will be self-determined with a prominent example being the Paris Agreement signed at the United Nations Framework Convention on Climate Change (UNFCCC) COP 21-2015. Paris Agreement recognized that the agreement would reflect Equity and Common but Differentiated Responsibilities. But despite strong references to justice, human rights, and equity in the Paris Agreement's preamble, the concept of equity is largely absent from its substantive components. The recent USA's withdrawal from the Paris Agreement also raises questions about the developed world's actions for equity policymaking. Several other challenges persist for equitable policymaking such as economic disparities, lack of representation of vulnerable, and tribals, resistance to accepting the historical emissions responsibility of the developed, and the policy implementation gaps even within the country. To ensure equity in policymaking, countries and governmental organizations must take some inspiration from the following; Prioritizing the inputs from the vulnerable populations and the locals leads to wide social acceptance of actions of the governments. For example, the Indian Government consults the tribal population before any developmental project in the tribal area. Greater responsibility must be taken by the developed world to phase out the greenhouse gases for example; Europe's Carbon Border Adjustment Mechanism ensures development with less carbon emissions. Norway has invested in retraining oil and gas workers to transition into renewable energy sectors, ensuring economic stability while reducing carbon emissions. Today, the multilateral institutions have become increasingly sensitive to the ill effects of climate change. The world has agreed that the most effective way to deal with the increasing temperatures is to make robust policies and stricter actions against the offenders. Hence, countries worldwide are coming up with strategies to include the negotiations mentioned in agreements like Glasgow Climate Impact 2021, African Union Climate Change Strategy and Action Plan etc. As it is rightly said, "Equity is the soul of public policy; without it, just remains a distant dream."³

Bhopal Gas Tragedy: A Failure of Environmental Justice

The Bhopal Gas Tragedy (1984) portrays a flawed picture of environmental justice—a symbol of persistent regulatory, legal, and social failures even in 2026—where Amnesty International and Supreme Court critiques highlight India's inadequate Water Act (1974) compared to U.S. Union Carbide plants, enabling the MIC gas leak (3,787+ official deaths, 500,000+ injured) that left groundwater and soil contaminated; the company's concealed toxicity data and insufficient 1989 \$470 million settlement (with 2023's additional ₹7,844 crore claim rejected) denied victims justice, while 337 tons of toxic waste incinerated in 2025 still leaves ash and chronic health crises (cancer, birth defects, respiratory issues) ongoing, exposing corporate evasion, weak government enforcement, and exploitation of poor communities, turning Bhopal into the "world's largest ongoing health emergency" with failed rehab schemes after 41 years.⁴

Inadequate institutional capacity and Bureaucratic Inefficiency

Most of the institutions of environmental agencies, such as the Central Pollution Control Board and State Pollution Control Boards, face shortages of resources, inadequate strength of staff, and lack of training, which thus limits the ability of these institutions to deliver on regular inspections, monitoring, and enforcement activities. The implementation of environmental laws is slowed by bureaucratic delays, red tape, and complex regulatory procedures. Such inefficiencies may delay any of these actions necessary, including issuing permits, enforcements with penalties against violators, and also corrective actions.

Economic Development vs. Environmental Conservation

Economic Pressures and Developmental Imperatives Economic Development vs. Environmental Conservation: Traditionally, economic growth has become a priority factor that gave impetus to the industrialization and urbanization processes, which slightly marginalized the concerns for environmental protection. Growth in infrastructure development, industrialization, and large-scale urbanization could sometimes lead to violations of environmental laws in pursuit of the economy. They tend to compromise on environmental sustainability to reap short-term fiscal benefits.⁵

Corruption and Lobbying

Corruption and lobbying play a significant role in weakening the effective implementation of environmental laws in India. Powerful industrial lobbies often influence policy decisions and regulatory processes to safeguard their economic interests, sometimes at the cost of environmental protection. At the same time, corruption within regulatory agencies—such as accepting bribes or yielding to political pressure—leads to selective enforcement or complete neglect of environmental regulations. This creates a gap between legal provisions and their practical execution, ultimately undermining environmental governance and sustainability efforts. (TaxGuru, n.d.)⁶

Lacking public awareness and participation

Lack of public awareness and participation significantly weakens the effective implementation of environmental laws. Many people, including industries and individuals, have limited knowledge of environmental regulations, their benefits, and the penalties for violations, which leads to unintentional non-compliance and general disregard for environmental



norms. At the same time, weak community participation further reduces the effectiveness of enforcement, as local communities often lack the resources, legal awareness, or institutional support needed to hold authorities accountable for environmental violations. In many cases, communities are also excluded from decision-making processes, resulting in poor oversight and continued environmental degradation. Therefore, improving environmental literacy and encouraging active public involvement are essential for strengthening environmental governance and ensuring sustainable development. (Tax Guru, n.d.)⁷

Poverty

Poverty and population explosion together pose a major challenge to environmental policy in India. With a population of over 1.4 billion, the country faces immense pressure on natural resources, as rising population increases the demand for water, land, food, and energy (World Bank, 2020; United Nations Department of Economic and Social Affairs [UNDESA], 2019). At the same time, poverty compels many people to depend directly on natural resources such as forests, land, and water for their livelihoods, leading to overexploitation and environmental degradation (United Nations Environment Programme [UNEP], 2019). As a result, the combined impact of poverty and population growth disrupts ecological balance and creates significant obstacles to achieving sustainable development (World Commission on Environment and Development [WCED], 1987).⁸

Population growth and resource strain

Population growth significantly intensifies pressure on natural resources, making sustainable environmental management increasingly difficult. As the population rises, the demand for essential resources such as water, food, and energy expands rapidly, often exceeding the regenerative capacity of ecosystems. This imbalance leads to the overexploitation of natural resources, manifesting in critical environmental problems such as water scarcity, soil degradation, deforestation, and loss of biodiversity. For instance, excessive extraction of groundwater for agriculture and domestic use contributes to declining water tables, while intensive farming practices accelerate soil erosion and reduce land productivity. Similarly, expanding urbanization and industrialization to meet the needs of a growing population result in habitat destruction and biodiversity loss. These challenges are further compounded in developing countries like India, where limited resources must support a large and growing population. [UNEP], 2019).⁹

Conclusion

Climate policy faces significant political, economic, and regulatory barriers that hinder its effective implementation. Political challenges arise from powerful stakeholders, such as fossil fuel industries, that resist policies threatening their economic interests. Additionally, short-term electoral cycles discourage long-term commitments, as seen in France's 2018 carbon tax protests. Economic barriers include the high costs of transitioning to low-carbon technologies, particularly for developing nations like India, which must balance emissions reduction with economic growth. Despite these challenges, successful policy examples from India and Colombia demonstrate that with strong governance, international cooperation, and innovative financing, barriers can be overcome.

Regulatory complexities further slow climate action due to bureaucratic inefficiencies and overlapping jurisdictions. Streamlining approval processes and adopting decentralized decision-making can improve efficiency, as seen in Uttarakhand's Van Panchayats and Germany's unified environmental assessment system. Similarly, stakeholder engagement enhances policy effectiveness by fostering transparency, inclusivity, and trust. Collaborative efforts, such as Odisha's post-Cyclone Phailin response, highlight how involving local communities improves resilience and policy acceptance.

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OriginalArticle

Role of Green Libraries in Climate Change and Global Policies

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Climate change represents one of the most significant challenges facing humanity in the 21st century, requiring integrated responses that combine environmental responsibility, social awareness and policy innovation. Libraries, traditionally viewed as repositories of knowledge are increasingly evolving into dynamic institutions that actively contribute to sustainability through the concept of green libraries. This paper examines the multifaceted role of green libraries in addressing climate change and supporting global environmental policy frameworks. It explores their contributions in sustainable infrastructure, environmental education, research facilitation and community engagement. The study also evaluates how green libraries support international initiatives such as those led by the United Nations and the International Federation of Library Associations and Institutions. Furthermore, the paper highlights challenges such as financial constraints, technological barriers and policy gaps while identifying future opportunities for strengthening the role of libraries in sustainability. The findings suggest that green libraries play a crucial role in bridging the gap between global environmental policies and local implementation.

Keywords:

Green Libraries; Climate Change; Sustainability; Environmental Education; SDGs; Policy Frameworks; India

Introduction

Climate change has emerged as a critical global issue characterized by rising temperatures, melting glaciers, biodiversity loss and extreme weather events. These changes are primarily driven by anthropogenic activities, including industrialization, deforestation and excessive consumption of fossil fuels. Addressing climate change requires coordinated efforts across governments, institutions and individuals.

In this context, libraries are gaining recognition as important actors in promoting sustainability. Traditionally, libraries have served as centers for knowledge preservation and dissemination. However, their role has expanded significantly in recent years to include social responsibility and environmental stewardship. The emergence of green libraries reflects this transformation as institutions adopt eco-friendly practices and promote sustainability awareness among users.

Green libraries are uniquely positioned to contribute to climate change mitigation due to their dual role as both operational entities and knowledge hubs. They can reduce their environmental footprint while simultaneously educating communities about sustainable practices. This paper aims to explore these roles in detail and examine how green libraries align with global policy frameworks.

Literature Review

The concept of green libraries has evolved over the past two decades, gaining increasing attention in academic and professional discourse. Early research focused on environmentally sustainable building design and energy efficiency in library infrastructure. Over time, the scope expanded to include environmental education, digital transformation, and community engagement.

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Antonelli (2008) provided one of the earliest comprehensive discussions of the green library movement, emphasizing the importance of environmental responsibility in library operations. Jankowska and Marcum (2010) further explored sustainability challenges in academic libraries, highlighting the need for institutional commitment and policy integration.

International organizations such as the UNESCO and the International Federation of Library Associations and Institutions have played a significant role in promoting sustainability within the library sector. These organizations advocate for the inclusion of libraries in global development agendas, particularly in relation to the Sustainable Development Goals.

In India, research on green libraries is still emerging but shows promising trends. Studies by Hasan and Panda (2023), Gogoi (2021), and Sharma and Sarkar (2024) highlight the adoption of sustainable practices in academic and public libraries. These studies also identify challenges such as limited funding, lack of awareness, and inadequate policy support.

Objectives of the Study:

The primary objectives of this research are:

- To analyze the concept and key features of green libraries
- To examine their role in climate change mitigation
- To evaluate their contribution to global environmental policies
- To identify challenges faced in implementing green libraries
- To explore future opportunities and recommendations

Research Methodology:

This study adopts a qualitative research approach based on secondary data. Information has been collected from academic journals, books, institutional reports and policy documents related to climate change and green libraries.

The data has been analyzed using a descriptive and analytical method, allowing for a comprehensive understanding of the subject. The study focuses on both global and Indian perspectives to provide a balanced view.

Concept and Components of Green Libraries:

5.1 Definition

A green library can be defined as an institution that integrates environmental sustainability into its design, operations and services. It aims to minimize environmental impact while promoting awareness and responsible resource use.

5.2 Core Components

5.2.1 Sustainable Architecture

Green libraries incorporate eco-friendly building designs that optimize natural lighting, ventilation and energy efficiency.

5.2.2 Resource Management

Efficient use of energy, water and materials is a key feature of green libraries. This includes the use of renewable energy sources and waste reduction practices.

5.2.3 Digital Transformation

The shift toward digital resources reduces the need for paper and physical storage, contributing to environmental conservation.

5.2.4 Environmental Education

Libraries organize programs and provide resources that promote awareness of environmental issues and sustainable practices.

Role of Green Libraries in Climate Change Mitigation:

6.1 Sustainable Infrastructure

Green libraries adopt energy-efficient technologies, such as LED lighting and solar panels to reduce their carbon footprint. These measures contribute to long-term environmental and economic benefits.

6.2 Environmental Awareness

Libraries play a vital role in educating the public about climate change. Through workshops, exhibitions and information resources, they encourage sustainable behavior.

6.3 Research and Knowledge Support

Access to reliable information is essential for addressing climate challenges. Libraries provide researchers and policymakers with the resources needed to develop effective solutions.

6.4 Community Engagement

Green libraries engage with communities through various initiatives, including recycling programs and environmental campaigns. These activities promote collective action and social responsibility.



Role in Global Policy Frameworks:

7.1 Alignment with SDGs

Green libraries contribute to global goals related to climate action, sustainable cities and responsible consumption. They support the implementation of these goals at the local level.

7.2 Policy Awareness

Libraries provide access to climate-related policies and reports, enabling individuals to make informed decisions.

7.3 International Collaboration

Through partnerships and networks, libraries participate in global sustainability efforts. Organizations such as the United Nations Framework Convention on Climate Change support these initiatives.

Challenges

8.1 Financial Constraints

High costs associated with green infrastructure limit adoption.

8.2 Technological Barriers

Lack of access to advanced technologies affects implementation.

8.3 Institutional Resistance

Limited awareness and resistance to change hinder progress.

8.4 Policy Limitations

Insufficient policy support reduces the effectiveness of green initiatives.

Opportunities and Future Scope:

9.1 Digital Expansion

Digital libraries reduce environmental impact and improve accessibility.

9.2 Smart Technologies

Advanced technologies can enhance sustainability and efficiency.

9.3 Policy Integration

Including libraries in climate policies can strengthen their role.

9.4 Capacity Building

Training programs can improve the implementation of green practices.

Indian Perspective

India is gradually adopting green library practices, particularly in higher education institutions. Initiatives such as solar energy use sustainable infrastructure and environmental awareness programs are becoming more common. However, challenges such as funding and technological access remain.

Conclusion

Green libraries represent a significant step toward integrating sustainability into institutional practices. By promoting environmental awareness, supporting research and engaging communities, they contribute to climate change mitigation and policy implementation. Strengthening their role through investment, policy support and innovation is essential for achieving sustainable development.

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Global Education Policies: Frameworks, Trends, and Impact in the 21st Century

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Education today is shaped not just by local needs but by global forces. Around the world, countries are working together to make education fairer, more effective, and better suited to the challenges of our changing world—whether that's new technology, migration, or climate change. This paper looks at how global education policies have changed and what impact they've had since 1990, focusing on big international efforts like Education for All, the Millennium Development Goals, and Sustainable Development Goal 4. It also considers the roles played by organizations such as UNESCO, the OECD, and the World Bank.

We explore how these global efforts influence what happens in classrooms, from funding and international tests like PISA, to the push for skills students will need for tomorrow's jobs. Four big trends stand out: moving from simply getting children into school to making sure they're actually learning, holding schools and systems more accountable, focusing on skills for the future, and responding to emergencies that disrupt education. To bring these ideas to life, we look at real examples from Finland, Kenya, and Brazil. These case studies show that while global policies can help mobilize resources and shine a spotlight on education, their success depends on local realities—like politics, institutions, and community support. The paper argues that for global education to truly work for everyone, policies need to respect local differences, give more say to countries in the Global South, and connect education to broader issues such as social protection and climate change. Otherwise, global policies risk repeating the very inequalities they aim to solve.

Keywords: Global Education Policies, Educational Reforms, SDG 4, Inclusive Education, Digital Learning, Educational Equity, Lifelong Learning, Educational Governance, 21st Century Skills, Globalization and Education.

Introduction

Education is no longer governed solely within national borders. Since the 1990 Jomtien World Conference on Education for All, a complex architecture of global education policies has emerged to set targets, mobilize finance, and define what counts as quality education. These policies operate through declarations, goals, indicators, comparative assessments, and conditional funding, creating what scholars call a “global education policy field.” The rationale for global policy is strong. Education outcomes have cross-border implications: skills shortages affect global labor markets; uneducated populations drive migration and instability, and pandemics or climate disasters disrupt schooling worldwide. Yet the legitimacy and effectiveness of global policies remain contested. Critics argue they impose Western models, narrow curricula to testable skills, and sideline teachers' voices.

This paper addresses three questions:

1. How have global education policy frameworks evolved since 1990?
2. What mechanisms do international organizations use to influence national education systems?
3. What evidence exists on the impact and limitations of global policies?

The analysis is grounded in policy sociology and comparative education, viewing global policies as ideas that are borrowed, translated, and resisted in diverse contexts.



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Evolution of Global Education Policy Frameworks

2.1 Education for All 1990–2015

The World Declaration on Education for All in Jomtien launched a global movement to meet basic learning needs.

The 2000 Dakar Framework set six goals: early childhood care, universal primary education, youth and adult learning, adult literacy, gender parity, and quality. EFA succeeded in raising primary enrollment from 82% to 91% globally and mobilized the Fast Track Initiative, later the Global Partnership for Education. However, it was criticized for neglecting secondary education and learning outcomes.

2.2 Millennium Development Goals 2000–2015

MDG 2 targeted universal primary completion, while MDG 3 promoted gender parity. The MDGs were powerful in agenda-setting and aid coordination but were narrow, focusing on access rather than learning. By 2015, 57 million children remained out of primary school, and 250 million children could not read despite attending school.

2.3 Sustainable Development Goal 4 2015–2030-

SDG 4 marked a paradigm shift: “Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.” Its 10 targets cover early childhood, technical and vocational training, higher education, skills for work, inclusion, literacy, and education for sustainable development. SDG 4.1 explicitly mentions learning outcomes, and SDG 4.7 introduces global citizenship. The scope is universal, applying to all countries, not just the Global South.

2.4 Regional Frameworks-

African Union Agenda 2063: Continental Education Strategy for Africa 2016–2025 emphasizes science, technology, and innovation.

European Education Area 2025: Aims for automatic recognition of diplomas and benchmarks on digital competence.

ASEAN Work Plan on Education 2021–2025: Focuses on resilience, digital learning, and TVET harmonization.

Key Actors and Instruments of Global Education Policy

3.1 International Organizations

Organization	Primary Role	Key Instruments
UNESCO	Norm-setting, monitoring-	GEM Report, Institute for Statistics, Conventions
World Bank	Financing, knowledge	Systems- Approach for Better Education Results, Human Capital Project
OECD	Benchmarking, policy advice	PISA, TALIS, Education at a Glance
Global Partnership for Education	Pooled funding	Education Sector Plan grants, \$5B mobilized since 2002
UNICEF	Equity, emergencies	Data Must Speak, Learning Passport

3.2 Policy Instruments

3.2.1 Goal Setting and Indicators- SDG 4 has 11 global and 32 thematic indicators. Indicators create pressure through naming and shaming. The Learning Poverty indicator, jointly developed by the World Bank and UNESCO, shows 70% of children in low-income countries cannot read by age 10.

3.2.2 International Large-Scale Assessments- PISA, TIMSS, PIRLS, and regional tests like PASEC and LLECE enable cross-national comparison. Over 90 countries participate in PISA. High rankings, like Finland and Singapore, shape global perceptions of best practice. Critics note teaching to the test and cultural bias.

3.2.3 Financing and Conditionality- GPE requires countries to commit 20% of budgets to education and develop credible sector plans. World Bank loans often include prior actions on teacher policy or curriculum reform. Education Cannot Wait funds education in crises, reaching 8.8 million children since 2016.

3.2.4 Knowledge Mobilization- Policy borrowing is facilitated through reports, study tours, and best practice databases. The OECD’s “Strong Performers and Successful Reformers” series diffuses ideas like autonomy with accountability.

Dominant Trends in Contemporary Global Education Policy

4.1 From Access to Learning- The “learning crisis” narrative emerged after data showed schooling did not guarantee learning. Policies now emphasize foundational literacy and numeracy, structured pedagogy, and teaching at the right level. The World Bank’s 2018 World Development Report was dedicated to learning.



4.2 Accountability and Datafication- Results-based financing, school report cards, and learning assessments have expanded. India's NITI Aayog ranks states on the School Education Quality Index. While data improves management, excessive testing can narrow curricula and stress teachers.

4.3 Skills for the Future of Work- Automation and AI have shifted policy to 21st-century skills: critical thinking, collaboration, digital literacy, and socio-emotional learning. The OECD Learning Compass 2030 and UNESCO's Futures of Education initiative promote competency-based curricula. TVET is repositioned from last resort to strategic sector, with the World Bank's \$2B Skills Toward Employment program.

4.4 Inclusion and Leave No One Behind- SDG 4.5 targets disability, indigenous peoples, and vulnerable children. Inclusive education policies promote mainstreaming over special schools. Gender-responsive education, multilingual education, and school feeding is scaled.

4.5 Education in Emergencies and Climate Resilience- Conflicts and climate disasters disrupted 224 million children's education in 2023. Global policies now integrate disaster risk reduction, safe schools, and digital remote learning. The Comprehensive School Safety Framework has been adopted in 68 countries.

Policy Transfer: Case Studies (Examples)

5.1 Finland: From Local Innovation to Global Model- Finland's trust-based system with no standardized testing, high teacher autonomy, and equity focus became a global reference after PISA 2000. Delegations from 100+ countries studied it. However, direct transfer failed in many contexts because Finland's success rested on the welfare state, low inequality, and cultural respect for teachers. This illustrates that policies are not plug-and-play.

5.2 Kenya: Global Goals and Local Adaptation- Influenced by EFA and SDG 4, Kenya introduced Free Primary Education in 2003 and 100% transition to secondary in 2018. GPE funding supported curriculum reform to competency-based education. Enrollment surged, but classrooms are overcrowded, and learning outcomes lag. Kenya shows global finance can expand access, yet quality requires system strengthening.

5.3 Brazil: Accountability and Equity- Responding to OECD benchmarks, Brazil created IDEB, a national quality index combining test scores and flow rates. Municipalities with low IDEB receive technical support. Between 2005 and 2021, learning poverty fell from 44% to 28%. Bolsa Familia conditional cash transfer, aligned with MDG/SDG agendas, reduced dropout. Brazil demonstrates how global metrics can be adapted to federal systems.

Impact and Critiques of Global Education Policies

6.1 Achievements- Resource Mobilization: Development aid for education reached \$15.6 billion in 2021. GPE helped 160 million children.

Norm Diffusion: Gender parity, inclusive education, and early childhood are now standard in national plans.

Data Revolution: 180 countries report on SDG 4. Learning assessments now cover 60% of children versus 20% in 2000.

6.2 Limitations and Unintended Effects- Standardization vs Context: Global indicators may ignore local knowledge. Emphasis is put on math and reading, sidelining arts and local languages.

Power Asymmetries: Agenda-setting is dominated by Northern donors and agencies. Only 3 of 26 GPE Board seats are held by developing country ministers.

Audit Culture: Excessive measurement leads to performativity. Teachers in Chile and the USA report teaching to the test under accountability regimes.

Financing Gap: SDG 4 requires \$39 billion more annually for low-income countries, but aid has plateaued since 2010.

Future Directions for Global Education Governance

1. Democratize Agenda-Setting: Increase representation of Global South governments, teachers' unions, and youth in GPE, UNESCO, and SDG processes.

2. Finance and Debt Justice: Implement the International Finance Facility for Education and address debt distress that constrains education budgets in 60 countries.

3. Beyond Learning Metrics: Develop holistic indicators for well-being, creativity, and climate literacy to counter narrow cognitivism.

4. Policy Coherence: Link education to health, social protection, and climate adaptation. School meals, cash transfers, and green school infrastructure have multiplier effects.

5. South-South Cooperation: Expand platforms like IBSA and ADEA for peer learning without Northern mediation.

Conclusion

Global education policies have transformed education from a national service into a shared human enterprise. They have undeniably expanded access and placed learning on political agendas. Yet the gap between global ambition and local reality persists. Policies travel through national bureaucracies, teacher beliefs, and community values, mutating in the process. The next decade requires humility in global governance. Rather than exporting models, international actors should support domestic problem-solving, fund what countries prioritize, and measure what communities value. The ultimate test of global education policy is not whether countries adopt similar reforms, but whether a Maasai girl in



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Kenya, a migrant boy in Lebanon, and a rural student in India all have a fair chance to learn, thrive, and shape their futures

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OriginalArticle

Digital Transformation in Banking: Opportunities and Challenges

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Digital transformation in banking presents opportunities for increased efficiency, financial inclusion, and personalized services, but also poses challenges related to legacy systems, cyber security, talent acquisition, and customer adoption. Banks must address these hurdles by investing in technology, strengthening Cyber security, and developing a skilled workforce to successfully navigate the shift from traditional to digital-first operations and meet evolving customer expectations.

Key words: Cybersecurity, technology, skilled workforce, digital operations, financial inclusion, customer expectations.

Introduction

The banking industry has undergone a profound transformation over the past decade, driven largely by rapid advancements in digital technologies. Digital transformation in banking refers to the integration of digital tools, processes, and innovative platforms that reshape traditional banking operations, enhance customer experiences, and improve overall efficiency. Technologies such as artificial intelligence (AI), machine learning, big data analytics, blockchain, cloud computing, and mobile banking applications are revolutionizing how financial institutions deliver services and engage with customers.

The shift toward digital banking has been accelerated by increasing customer expectations for convenient, fast, and secure financial services, along with intense competition from fintech companies and regulatory pushes for greater transparency and efficiency. Digital transformation enables banks to streamline operations, reduce costs, improve decision-making, and offer personalized services. At the same time, it opens new avenues for financial inclusion, allowing previously underserved populations to access essential banking services through digital channels.

Objectives

The objectives of digital transformation in banking include enhancing customer experience through personalized and 24/7 service, increasing operational efficiency by automating tasks and reducing costs, and fostering innovation by creating new business models and products using technologies like AI and blockchain. Banks also aim to improve security, simplify compliance, and gain a competitive edge in a rapidly digitizing market.

To comprehend the present situation of digital transformation in the banking sector based on a systematic literature review.

1. To establish the major determinants of the success of digital transformation in banking.
2. To examine the role of digital transformation on customer experience.
3. To recognise the gaps and set a future research agenda.
4. To utilize a SWOC framework (Strengths, Weaknesses, Opportunities, Challenges) to assess the strategic alignment of digital banking initiatives.
5. To propose a specific research question for empirical study



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Need For Digitalization in the Indian Banking Sector

The Indian banking sector realized the need for computerization in the late 1980s to improve customer service, book-keeping, and record-keeping. In 1988, the Reserve Bank of India formed a committee chaired by Dr. C. Rangarajan to investigate computerization in banks. The computerization trend increased during the Indian economy's reformation from 1991 to 1992. One of the main causes of this development was the growing involvement of private and foreign banks in the banking industry. To stay competitive and relevant in the race, several commercial banks started to transition towards digital service delivery. The introduction of MICR-based cheque processing, electronic fund transfers, branch interconnection, and ATM adoption have made banking time more convenient for commercial banks in India. Many were forced to use mobile banking or digital payment during the demonetization era due to a lack of cash, which appeared to be a better option for them. The Indian government is currently heavily promoting digital payments. The National which are the two essential components of the payment system. Customers can send money between accounts at several banks utilizing the UPI mobile platform by using a virtual address rather than their actual bank account numbers. Payments Corporation of India introduced United Payments Interface (UPI) and Bharat Interface for Money,

Role of Digitization in Indian Banking

The majority of Indian banks were quite hesitant to implement the changes brought about by technological innovation. The mechanization and digitization of the Indian banking sector were caused by a variety of factors. The initial step towards digital transformation in banking was the implementation of standard check encoders i.e., Magnetic Ink Character Recognition (MICR) code. Now, each bank branch has a unique MICR code which facilitates the sorting and processing of checks. The step of implementation of unique MICR code was more of an innovation than a necessity which ultimately eases the banking operations. Banks started integrating computer technology with personal computers and subsequently set up their own local area networks (LAN) to reduce errors and speed up the process. Due to growth of networks, the banks began to connect with each other, this results in the evolution of Centralized Online Real-time Exchange (CORE) banking... Customers were able to conduct financial transactions and view their accounts from any of the partner banks' branches using CORE banking. Customers could manage bank accounts more easily, which gradually inspired the term "Anytime, Anywhere Banking". Eventually automated teller machines (ATMs) were on the scene, making it feasible to conduct electronic transactions of funds. In the 2000s, online banking and tele-banking were introduced, and various methods of online fund transfers, such as Real Time Gross Settlement (RTGS) and Immediate Payment Service (IMPS), were implemented. National Electronic Funds Transfer (NEFT) is an electronic funds transfer system started in 2005 by the Reserve Bank of India (RBI), which enables bank customers in India to transfer funds between any two NEFT-enabled bank accounts on a one-to-one basis. Online innovation services and mobile banking have both grown in popularity in recent years. The Indian banking industry's transition to digitalization, which started in the 1980s, has come a long way.

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OriginalArticle

The Role of Digital Libraries in Modern Accreditation

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Digital libraries have emerged as a cornerstone of modern higher education systems, significantly influencing accreditation processes worldwide. Accreditation bodies increasingly evaluate institutional quality based on digital infrastructure, accessibility of scholarly resources, and integration of information and communication technologies (ICT). This paper explores the evolving role of digital libraries in modern accreditation frameworks, particularly in higher education institutions (HEIs). It examines how digital libraries enhance teaching-learning processes, research productivity, governance, and quality assurance. The study also highlights accreditation criteria such as those of NAAC (India), where library digitization contributes directly to institutional grading. Furthermore, challenges such as digital preservation, intellectual property rights, and infrastructure disparities are analyzed. The paper concludes with recommendations for optimizing digital library systems to meet accreditation standards and sustain academic excellence.

Keywords: Digital Libraries, Accreditation, NAAC, Higher Education, ICT, Role of Digital Libraries in Accreditation.

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Introduction

The evolution of information and communication technologies (ICT) has significantly reshaped the structure and functioning of higher education systems. One of the most notable developments in this transformation is the emergence of digital libraries, which provide organized access to electronic resources such as e-books, online journals, databases, and institutional repositories. Unlike traditional libraries, digital libraries enable users to access information anytime and from anywhere, thereby enhancing the efficiency of teaching, learning, and research activities.

At the same time, accreditation has become an essential mechanism for ensuring quality and accountability in higher education institutions. Accreditation bodies evaluate institutions based on various criteria, including infrastructure, academic resources, research output, and student support systems. In India, the National Assessment and Accreditation Council (NAAC) places strong emphasis on the availability and effective use of digital learning resources, particularly digital libraries, under its quality assessment framework. Digital libraries play a vital role in meeting accreditation standards by supporting academic excellence and institutional development. They enhance the teaching-learning process by providing access to updated and diverse study materials, facilitate research through scholarly databases and repositories, and improve institutional visibility by showcasing academic outputs. Additionally, digital libraries support documentation and data management, which are critical during accreditation evaluation. However, despite their importance, institutions face several challenges in implementing digital libraries effectively. Issues such as limited funding, technological barriers, lack of trained personnel, and unequal access to digital infrastructure can affect their performance and impact on accreditation outcomes.



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Therefore, understanding the role of digital libraries in modern accreditation is essential. This paper examines how digital libraries contribute to quality assurance in higher education and highlights their significance in achieving better accreditation results.

Objectives of the Study

The present study aims to examine the role of digital libraries in modern accreditation systems in higher education. The specific objectives are:

1. To understand the concept and importance of digital libraries in higher education.
2. To analyze the role of digital libraries in enhancing teaching, learning, and research.
3. To examine the contribution of digital libraries in accreditation processes, especially by the National Assessment and Accreditation Council.
4. To identify the challenges faced in implementing digital libraries.
5. To suggest best practices for improving digital library services in the context of accreditation.

Research Methodology

This study is based on a descriptive research design using secondary data. Information has been collected from books, research articles, journals, and reports of organizations such as the National Assessment and Accreditation Council. The data is analyzed qualitatively to understand the role of digital libraries in accreditation. The study mainly focuses on higher education institutions and examines how digital libraries support teaching, research, and quality assurance.

Concept of Digital Libraries -

Digital libraries are organized collections of digital content that provide access to information resources through electronic means. They allow storage, preservation, and dissemination of knowledge across geographical boundaries.

1. International Federation of Library Associations and Institutions (IFLA)-

“A digital library is an online collection of digital objects of assured quality that are created or collected and managed according to internationally accepted principles.”

2. William Y. Arms (2000) -

“A digital library is a managed collection of information, with associated services, where the information is stored in digital formats and accessible over a network.”

Key Features of Digital Libraries -

- **24/7 Accessibility:** Users can access resources anytime and from anywhere without physical restrictions.
- **Remote Access:** Information is available through the internet, allowing users to study and research from distant locations.
- **Multimedia Support:** Digital libraries include text, images, audio, video, and interactive content, enhancing the learning experience.
- **Efficient Search and Retrieval:** Advanced search tools, keywords, and filters help users find information quickly.
- **Preservation of Information:** Digital formats allow long-term storage and protection of valuable academic resources.
- **Up-to-date Content:** Continuous updates ensure access to the latest research and developments.

Importance of Digital Libraries in Higher Education-

1. Digital libraries play a crucial role in strengthening higher education by improving access to information, supporting research, and enhancing the overall quality of academic activities.
2. **Easy and Anytime Access to Information-**
Digital libraries provide 24/7 access to e-books, journals, and databases. Students and faculty can access study materials anytime and from anywhere, making learning more flexible and convenient.
3. **Support for Teaching and Learning-**
They enhance the teaching-learning process by offering updated and diverse academic resources. Digital libraries support e-learning, blended learning, and online education, improving student engagement and understanding.
4. **Promotion of Research and Innovation-**
Digital libraries give access to peer-reviewed journals, research databases, and institutional repositories, helping researchers stay updated and produce quality research work.
5. **Cost-Effective Resource Sharing-**
They reduce the need for physical books and allow institutions to share resources through digital platforms, making them more economical in the long run.
6. **Accessibility and Inclusivity-**
Digital libraries ensure equal access to knowledge for all learners, including remote students and differently-abled users, promoting inclusive education.



7. Enhancement of Institutional Quality-

Well-developed digital library services improve academic standards and play an important role in accreditation processes conducted by bodies like the National Assessment and Accreditation Council.

8. Global Exposure and Knowledge Sharing-

They enable access to international resources and promote collaboration among institutions, increasing global exposure and academic networking.

Accreditation in Higher Education -

Accreditation in higher education is a process that evaluates the quality and performance of educational institutions based on set standards. It ensures academic excellence, accountability, and continuous improvement. Institutions are assessed on key areas such as infrastructure and learning resources, research output, teaching–learning processes, and governance.

In India, the National Assessment and Accreditation Council (NAAC) play a major role in this evaluation. It gives importance to library services under infrastructure and academic support systems. With the growth of technology, digital libraries have become an important factor in accreditation. They provide easy access to updated resources, support teaching and research, and help maintain proper records and data. As a result, effective digital library systems contribute significantly to improving accreditation scores and overall institutional quality.

1. Role of Digital Libraries in Accreditation -

2. Digital libraries play a significant role in strengthening the accreditation process of higher education institutions. They support various academic and administrative functions, directly contributing to quality enhancement and better accreditation outcomes.

3. Enhancing Teaching and Learning-

4. Digital libraries improve the quality of education by providing easy access to e-books, journals, databases, and course materials. They support modern teaching methods such as blended learning and e-learning, while also enabling remote access to academic content. This enhances student engagement and learning effectiveness, which aligns with accreditation criteria related to teaching–learning processes.

5. Supporting Research and Innovation-

6. Digital libraries contribute to research development by offering access to peer-reviewed journals and scholarly databases. They also provide institutional repositories for storing research work and tools for citation tracking and indexing. These features help increase research productivity, which is an important parameter in accreditation frameworks.

7. Improving Accessibility and Inclusivity-

8. Digital libraries ensure equal access to information for all users, regardless of location or physical limitations. They support remote learners, provide assistive technologies, and promote open access resources. This inclusivity enhances institutional credibility during accreditation evaluation.

9. Strengthening Institutional Visibility-

10. Through digital repositories, institutions can showcase their academic work globally. This increases visibility, improves citation impact, and attracts academic collaborations. As a result, digital libraries contribute to building a strong institutional reputation.

11. Supporting Quality Assurance-

12. Digital libraries help in maintaining quality standards by providing usage statistics, reports, and analytics. These data-driven insights assist in resource optimization and support evidence-based evaluation during accreditation. They act as measurable indicators of institutional performance.

13. Alignment with Accreditation Criteria-

In India, the National Assessment and Accreditation Council (NAAC) include digital library services under multiple criteria, such as:

- **Criterion IV:** Infrastructure and Learning Resources
- **Criterion II:** Teaching–Learning and Evaluation
- **Criterion III:** Research, Innovations, and Extension

Thus, well-developed digital libraries are essential for meeting accreditation standards and achieving higher grades.

Challenges in Implementing Digital Libraries -

Although digital libraries offer numerous advantages, their implementation in higher education institutions is accompanied by several challenges. These issues can affect their effectiveness and limit their contribution to accreditation and academic quality.



1. Digital Divide-

One of the major challenges is the digital divide, which refers to unequal access to technology and internet connectivity. Institutions in rural or economically weaker regions often lack adequate infrastructure, resulting in limited access to digital library resources. This creates inequality among students and institutions.

2. Intellectual Property Issues-

Digital libraries must comply with copyright laws and licensing agreements. Restrictions on the use, sharing, and reproduction of digital content can limit access to important academic resources. Managing these legal aspects becomes a complex task for institutions.

3. Lack of Standardization-

Many digital libraries do not follow uniform metadata standards or interoperability protocols. This lack of standardization makes it difficult to organize, share, and retrieve information efficiently, thereby affecting usability and integration with other systems.

4. Infrastructure and Cost-

The development and maintenance of digital libraries require significant investment in hardware, software, subscriptions to databases, and technical support. For many institutions, especially those with limited funding, these costs become a major barrier.

5. Digital Preservation-

Ensuring the long-term preservation of digital content is a critical challenge. Digital data can become obsolete due to changing technologies, file formats, or system failures. Institutions need proper strategies to maintain and protect digital resources over time.

Best Practices for Digital Libraries in Accreditation-

To effectively contribute to accreditation, digital libraries must follow certain best practices that enhance their efficiency, usability, and alignment with quality standards.

1. Adoption of Integrated Library Management Systems (ILMS)-

Implementing ILMS helps in automating library operations such as cataloging, circulation, and user management. It improves efficiency, accuracy, and accessibility of library services.

2. Implementation of Institutional Repositories-

Institutions should develop digital repositories to store and showcase research outputs such as thesis, dissertations, and faculty publications. This improves research visibility and supports accreditation requirements.

3. Subscription to E-Databases-

Access to reputed academic databases like JSTOR and Scopus provides high-quality, peer-reviewed content. These resources strengthen teaching and research activities.

4. Training Programs for Users and Staff-

Regular training sessions should be conducted to enhance digital literacy among students, faculty, and library staff. Proper training ensures effective utilization of digital resources.

5. Use of Analytics for Decision-Making-

Digital libraries should use data analytics tools to monitor usage patterns, resource demand, and user behavior. This helps in better resource planning and evidence-based decision-making.

6. Collaboration with National Digital Initiatives-

Libraries should collaborate with national-level initiatives such as INFLIBNET Centre to access shared resources and improve service quality.

Future Trends in Digital Libraries -

The future of digital libraries is shaped by emerging technologies and innovative approaches that will further strengthen their role in education and accreditation.

1. Artificial Intelligence in Information Retrieval -

AI-based systems can improve search accuracy, recommend relevant resources, and enhance user experience through intelligent automation.

2. Cloud-Based Digital Libraries -

Cloud technology enables scalable storage, remote access, and cost-effective management of digital resources, making libraries more efficient and flexible.

3. Open Access and Open Educational Resources (OER) -

The growth of open access platforms and OER promotes free availability of academic content, increasing accessibility and supporting inclusive education.

4. Blockchain for Digital Rights Management -

Blockchain technology can ensure secure and transparent management of digital rights, protecting intellectual property and maintaining data integrity.



5. Personalized Learning through Digital Platforms -

Digital libraries integrated with learning platforms can provide personalized content recommendations, supporting individual learning needs

Conclusion-

Digital libraries have become an essential component of modern accreditation processes in higher education. They play a crucial role in enhancing the quality of teaching and learning by providing easy access to updated academic resources. At the same time, they support research activities, improve accessibility for diverse learners, and increase the global visibility of institutional outputs. Accreditation agencies such as the National Assessment and Accreditation Council increasingly consider digital infrastructure, especially digital library services, as an important indicator of institutional quality. A well-developed digital library reflects an institution's commitment to academic excellence, innovation, and effective resource management. Although there are challenges such as infrastructure limitations, cost, and digital divide, these can be addressed through proper planning, investment, and adoption of best practices. Continuous technological advancements and innovative approaches further strengthen the effectiveness of digital libraries.

In conclusion, institutions that successfully implement and utilize digital library systems are better equipped to achieve higher accreditation grades and gain recognition at both national and global levels.

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OriginalArticle

Skill Development Programs for Sustainable Futures among College Students: A Review Literature

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In the rapidly changing global environment, sustainable development has become one of the most significant priorities across nations. Increasing environmental degradation, climate change, resource depletion, unemployment, and social inequality have highlighted the urgent need for developing sustainable solutions. In this context, higher education institutions are expected not only to provide academic knowledge but also to equip students with essential skills required for sustainable futures. Skill development programs have emerged as important educational interventions that enhance students' competencies in critical thinking, problem-solving, communication, collaboration, leadership, environmental awareness, and ethical decision-making. The present paper reviews existing literature related to skill development programs for sustainable futures among college students. The review focuses on sustainability competencies, educational approaches, implementation challenges, and future directions. The findings suggest that although sustainability skill development has gained considerable attention, gaps still exist in curriculum integration, practical exposure, faculty preparedness, and institutional commitment.

Keywords: Sustainable development, skill development, , sustainability competencies, higher education, future skills.

Introduction

Sustainable development has emerged as a major global concern in the twenty-first century due to increasing environmental degradation, climate change, depletion of natural resources, rapid industrialization, and widening social and economic inequalities (World Commission on Environment and Development [WCED], 1987). The concept of sustainable development was formally introduced in the Brundtland Report, which defined it as development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs (WCED, 1987). This concept established a foundation for balancing economic growth, environmental protection, and social equity in developmental policies and practices. The global importance of sustainable development was further strengthened with the adoption of the 2030 Agenda for Sustainable Development by the United Nations in 2015. This agenda introduced seventeen Sustainable Development Goals (SDGs), focusing on critical areas such as quality education, climate action, clean energy, sustainable communities, responsible consumption, and reduced inequalities (United Nations, 2015). These goals emphasize the importance of developing human capacities and institutional frameworks to ensure long-term sustainability. Education is widely recognized as a crucial mechanism for achieving sustainable development because it enables individuals to acquire knowledge, values, attitudes, and competencies necessary for addressing sustainability challenges (UNESCO, 2017). According to UNESCO, education for sustainable development promotes informed decision-making, critical reflection, and responsible action, all of which are essential for building sustainable societies. (UNESCO, 2017). In the present era, traditional academic knowledge alone is insufficient to prepare students for rapidly evolving global challenges

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College students require a broad range of competencies such as critical thinking, communication, collaboration, creativity, leadership, ethical reasoning, systems thinking, and problem-solving abilities (Wiek, Withycombe, & Redman, 2011). These competencies, often referred to as sustainability skills or future skills, are necessary for understanding interconnected environmental, economic, and social issues and for designing innovative solutions (Wiek et al., 2011).

Higher education institutions play a significant role in promoting sustainability competencies among students. Universities and colleges are not merely centers of knowledge dissemination but are also important spaces for developing socially responsible and environmentally conscious citizens (Sterling, 2004). Higher education contributes to sustainability through curriculum integration, research, campus sustainability initiatives, community engagement, and co-curricular activities (Lozano et al., 2017). Skill development programs designed for sustainable futures have gained increasing importance in higher education. These programs typically include workshops, project-based learning, internships, leadership development, entrepreneurship training, environmental awareness activities, and service-learning opportunities (Bell, 2010; Brundiers & Wiek, 2017). Such programs are intended to enhance students' employability while simultaneously fostering sustainability-oriented competencies and responsible citizenship (OECD, 2018). Research indicates that experiential and project-based learning approaches are particularly effective for sustainability education because they provide students with opportunities to engage in real-world problem-solving and interdisciplinary collaboration (Kolb, 1984; Bell, 2010). These pedagogical approaches encourage active participation, reflection, and application of theoretical knowledge in practical settings.

Despite growing recognition of sustainability education, several challenges remain. Many institutions continue to prioritize traditional lecture-based teaching methods, with limited emphasis on practical skill development and interdisciplinary learning (Tilbury, 2011). Additionally, inadequate faculty training, lack of institutional commitment, limited resources, and low student engagement often hinder effective implementation of sustainability programs (Lozano et al., 2017). College students represent a critical target group for sustainability skill development because they are future professionals, policymakers, entrepreneurs, and community leaders. Their preparedness to address sustainability challenges depends substantially on the quality and accessibility of educational opportunities provided during higher education (UNESCO, 2017). Therefore, reviewing literature related to skill development programs for sustainable futures among college students is essential for identifying effective practices, existing gaps, and future directions.

Objectives

The present review was undertaken with the following objectives:

1. To review existing literature related to skill development programs for sustainable futures among college students.
2. To identify key sustainability competencies, educational approaches, implementation challenges

Concept of Sustainable Development Skills

Sustainable development skills refer to the competencies required for promoting environmentally responsible, socially equitable, and economically viable practices. According to UNESCO (2017), sustainability competencies include knowledge, attitudes, values, and practical abilities necessary to contribute toward sustainable societies.

Wiek, Withycombe, and Redman (2011) identified five major sustainability competencies:

- Systems-thinking competency
- Anticipatory competency
- Normative competency
- Strategic competency
- Interpersonal competency

Systems thinking enables students to understand relationships between environmental, social, and economic systems. Anticipatory competency involves forecasting future consequences of present actions. Normative competency focuses on ethical considerations and values. Strategic competency supports planning and implementation of sustainability interventions, while interpersonal competency enhances teamwork and collaboration (Wiek et al., 2011). Recent studies further emphasize digital literacy, innovation, adaptability, and resilience as important future skills for sustainable development (World Economic Forum, 2020).

Role of Higher Education in Sustainability Skill Development

Higher education institutions play a central role in promoting sustainability competencies among students. Universities influence not only academic learning but also attitudes, behaviors, and civic responsibility.

UNESCO (2017) highlights that education for sustainable development should be integrated into all levels of education. In higher education, sustainability can be embedded through:

- Curriculum integration
- Campus sustainability initiatives
- Community engagement



- Research activities
- Co-curricular programs

Sterling (2004) argues that sustainability requires transformative learning rather than traditional knowledge transmission. Students must be encouraged to critically examine real-world problems and develop innovative solutions. Lozano et al. (2017) found that universities implementing sustainability frameworks improved students' awareness, responsibility, and problem-solving capacity. However, implementation varies significantly across institutions and countries.

Skill Development Programs for Sustainable Futures

Skill development programs for sustainable futures are structured educational initiatives designed to enhance competencies relevant to sustainability.

Common programs include:

- Workshops
- Seminars
- Internships
- Leadership programs
- Service-learning
- Community projects
- Project-based learning
- Environmental campaigns

Research indicates that participation in these programs improves employability and sustainability awareness.

Brundiers and Wiek (2017) reported that experiential sustainability programs enhance students' practical problem-solving abilities. Similarly, service-learning initiatives improve civic engagement and social responsibility (Clevenger & Ozbek, 2013).

Project-based learning has been identified as especially effective because it exposes students to authentic sustainability challenges requiring interdisciplinary solutions (Thomas, 2000).

Pedagogical Approaches for Sustainability Skill Development

Several educational approaches have been recommended for sustainability skill development.

- **Experiential Learning:** Kolb (1984) proposed experiential learning as a cyclical process involving experience, reflection, conceptualization, and experimentation. Sustainability education benefits significantly from practical engagement.
- **Project-Based Learning:** Project-based learning allows students to investigate complex issues and develop solutions. Bell (2010) noted that project-based learning promotes collaboration, creativity, and real-world application.
- **Interdisciplinary Learning:** Sustainability challenges are inherently interdisciplinary. Barth et al. (2007) emphasize the importance of integrating knowledge across disciplines.
- **Digital Learning:** Digital platforms, simulations, and virtual collaboration tools increasingly support sustainability learning (Mahmud & Kurt, 2026).

Conclusion

The reviewed literature demonstrates that skill development programs are essential for preparing college students for sustainable futures. Sustainability competencies such as critical thinking, collaboration, systems thinking, leadership, and ethical reasoning are increasingly necessary in higher education and future employment. Although universities are making progress in sustainability education, implementation remains inconsistent. Significant gaps persist in curriculum integration, faculty development, and practical exposure. Higher education institutions must adopt holistic and interdisciplinary approaches to sustainability skill development. Stronger policy frameworks, institutional commitment, and innovative pedagogical practices are required to ensure effective preparation of students for future sustainability challenges.

Recommendations

- Integrate sustainability competencies into all academic disciplines
- Strengthen experiential and project-based learning
- Conduct faculty training programs
- Develop sustainability assessment tools
- Promote partnerships with industry and communities



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OriginalArticle

Impact of Dr. Babasaheb Ambedkar's Conversion: Special Reference to Beed and Osmanabad districts

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Dr. Babasaheb Ambedkar's historic conversion to Buddhism on 14 October 1956 marked a significant socio-cultural and religious transformation in India, particularly among the marginalized sections of society. This study examines the impact of Ambedkar's conversion movement with special reference to Beed and Osmanabad districts of Maharashtra. The research explores the changes in social status, educational awareness, political participation, cultural identity, and religious practices among the Neo-Buddhist communities in these regions. The conversion movement inspired a sense of self-respect, equality, and social justice, leading to increased educational aspirations and socio-economic mobility among the followers. The study also highlights the role of Buddhist organizations, community leaders, and educational institutions in promoting Ambedkarite ideology and strengthening collective consciousness. Despite various challenges, the influence of Ambedkar's conversion continues to shape the social and cultural landscape of Beed and Osmanabad districts. The findings emphasize that the conversion movement was not merely a religious change but a broader struggle for human dignity, empowerment, and social transformation.

Keywords: Dr. Babasaheb Ambedkar, Conversion to Buddhism, Neo-Buddhist Movement, Beed District, Osmanabad District, Social Transformation, Social Justice, Dalit Empowerment, Ambedkarite Ideology, Educational Awareness, Equality, Human Dignity.

Introduction

Dr. Babasaheb Ambedkar accepted Buddhism on 14th October 1956 after realizing that freedom, equality and brotherhood could not be established in Hinduism despite all efforts. The conversion to Buddhism led to a great ideological revolution in the minds of the newly converted Buddhists. They underwent a major mental change. This change has a solid foundation of thought, a foundation of faith as well as unwavering faith in their leader. This has affected the entire country, as well as Beed and Osmanabad districts. Dr. Babasaheb Ambedkar's followers have been affected as a whole.

Research Objectives

the impact of Dr. Babasaheb Ambedkar's the religious thoughts.
To study the effects of Dr. Babasaheb Ambedkar's conversion on the people in Beed and Osmanabad district.

Research Hypothesis

Dr. Babasaheb Ambedkar's religious views are revolutionary.
Babasaheb Ambedkar's conversion has had a profound effect on the people in Beed and Osmanabad districts.

Research Methods

A large number of primary tools for this research are direct surveys,
Adopted an analytical research approach using direct interviews has arrived in the research paper.



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Mental changes

The conversion to Buddhism had a profound and profound effect on the newly converted Buddhists. There was a big change in their minds, this is a mental change. "I have accepted the Buddhist Dhamma, I am now a Buddhist, not an untouchable, I have become a real human being. I have now become a man equal to the senior Hindu. I am no longer inferior, not inferior. With my acceptance of Buddhism, my untouchability disappeared. The chains of untouchability on my feet broke. Now that I am a human being, I have come to a world of equality, freedom, brotherhood, justice, and friendship. I am no longer a slave of a senior Hindu; I am no longer a permanent servant carrying the burden of slavery. I am free now; I am free citizen of the independent India.1

Buddhists renounced Hindu deities: -

After conversion, Buddhists completely abandoned Hindu deities. Prior to Dhammadiksha, the untouchable community believed in Hindu deities. But after conversion, they threw away idols, photos and myths of Hindu deities. Making vows to the deities like Marimaya, Mhasoba, Khandoba etc. was completely abandoned and visiting pilgrimage places was also stopped. Abhangas, hymns and ovyas of Hindu deities were given up. Instead of photos of Hindu deities in Buddhist homes, Gautam Buddha and Dr. Ambedkar's photos were appeared. I stopped going to astrologers and looking at time and moments. In the morning and evening in the Buddhist monasteries, people started offering mass worship with candles and incense. People stoped visiting Hindu places of pilgrimage and visit Dikshabhoomi of Nagpur, Chaityabhoomi of Mumbai, Babasaheb's birthplace Mhahu, Sarnath, Buddhagaya, Lumbini, Sanchi, Buddhist caves, Dragon Palace of Kamati etc. 2.

Changes in marriage law: -

Based on the actual survey, it was found that the biggest and most visible change after conversion is the Buddhist marriage ceremony. The neo-Buddhist marriage ritual has been followed, abandoning the oldest and most complicated customs of previous marriages. Buddhist marriage rites are considered an ideal marriage rite. The bride and groom are sworn in to fulfill their duties for a successful family life. The horoscope of the bride and groom is not considered in deciding the marriage. Also, the date and time of marriage is not decided by looking at the almanac. Another aspect of conversion is that the former caste is not taken into consideration when deciding on marriage. This will soon unite the Buddhist community. 3

Superstitions and conversions in Buddhism: -

It is seen that many superstitions in the Buddhist community have decreased after conversion. In the past, sorcerers used to carry ropes around the neck or rod of a sick person, vows were made to the goddess to cut cocks, goats, embers, incense, auspicious, inauspicious, deeds, ghost farms, pind-dana etc. At present, superstition in the Buddhist community has greatly diminished. Now he does not believe in God. Their belief in God and demons has diminished. Buddhists no longer believe in reincarnation. The marriage of a boy and a girl is decided from the village, from the city, according to the convenience of both the parties. 4

Effects on Addiction: -

Before conversion, the untouchables used to drink palm, alcohol, opium and marijuana. Alcohol consumption has decreased after conversion. It has been found that many educated and uneducated people also drink alcohol. But even non-drinkers make up 30 to 40 percent of the population. Converts call it Buddha Vandana on the day of marriage, naming ceremony, every Purnima. Sikka Padam Samadhiyami |, which means, I take the teaching of abstaining from the use of honey as well as tempting intoxicants. These lines put a little bit of moral pressure on them. So there is definitely a bit of a preventative effect on their drinking. Also Dr. Ambedkar was against alcohol. Due to the habit of drinking alcohol, the untouchables have degraded themselves and the society. They tell women, "Don't feed drunken husbands, brothers, children, educate children, women need both knowledge and learning. Without it, a just society will not happen. "5

There was an educational revolution

Dr. Babasaheb Ambedkar says about education, "Education is the highway to eliminate all forms of inequality and achieve social democracy". The conversion at Diksha Bhoomi Nagpur in 1956 brought Buddhists to understand the thoughts of Dr. Babasaheb Ambedkar and Gautam Buddha, because the Buddha is called as knowledge light. The Buddhists have understood this. So, he gave importance to education. Dr. Babasaheb Ambedkar had said, "Learn, unite and struggle." This had a huge impact. The level of Buddhist education after conversion is significant. The numbers of graduates are increasing day by day. People of this religion are working in various positions like Vice Chancellor, Registrar, Principal, Member of Planning Commission, Director of Government Department, and Judge. The quality of Buddhism is being realized. 6

An international relation developed: -



Before the conversion, the people from Beed and Osmanabad districts were unknown about the Buddha countries. As the conversion happened the people from the district went to the countries like Japan, China, Shilon, Bhutan, Thailand, Vietnam, Cambodia, Laos, and Nepal, to see the Buddha culture and to learn Buddha philosophy. They are now the residents of that country and established the new relations there. The people from other country are coming to India to see the Buddha caves, Stupas, Chaityas, Viharas. This is the place of Buddha and it has too much importance for the foreigner.⁷

Conclusion

1. An important effect on the converts in Beed and Osmanabad districts is that they have undergone a mental transformation.
2. Buddhists reduced their belief in deities.
3. The change in marriage system is started as, Buddhism started.
4. Converted Buddhists gave importance to Scientifics.
5. Staying away from addiction As Buddhist philosophy says, addiction seems to be decreasing.
6. A society that used to live in ignorance is advancing in education.
7. Behavior is turning towards Buddhist way, leaving the previous behavior. The number of Buddhist monasteries is increasing; all the important events are being held in a Buddhist manner. Changes are seen in the design of houses.

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OriginalArticle

Design and Development of Motor Operated Mini Pulverizer Machine

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The increasing demand for powdered agricultural and herbal products such as turmeric, spices, and grains has created a need for efficient and compact grinding machines. Traditional manual grinding methods are time-consuming, labor-intensive, and produce non-uniform particle sizes. This research paper presents the design, fabrication, and performance evaluation of a motor-operated mini pulverizer machine suitable for small-scale and rural applications. The machine is powered by a 3 HP single-phase motor and operates using a belt and pulley mechanism to drive a rotating blade system inside a grinding chamber. Experimental results indicate that the machine achieves an efficiency of 70–80% with uniform particle size output. The developed system offers a cost-effective, portable, and efficient solution for small-scale industries, reducing manual effort and increasing productivity.

Keywords—Mini Pulverizer, Size Reduction, Agricultural Processing, Grinding Machine, Turmeric Powder, V-Belt Drive

Introduction

Pulverization is a critical process in agricultural and food processing industries, where solid materials are reduced into fine particles. Products such as turmeric, spices, grains, and herbal leaves require grinding to improve usability, storage, and market value. Traditionally, grinding is performed manually using mortar and pestle or small grinders, which limits productivity and consistency. Turmeric, widely used for its medicinal properties due to curcumin content, requires fine grinding to retain its effectiveness. However, manual grinding methods are inefficient and produce uneven particle sizes. Large industrial pulverizers are available but are expensive and unsuitable for small-scale users. This study focuses on developing a compact motor-operated mini pulverizer that can increase productivity, reduce manual labor, provide uniform grinding, and be affordable and easy to operate.

Literature Review

Various studies have explored pulverizer machines and grinding mechanisms. Pulverizers operate based on impact, shear, and compression forces. Key performance parameters include efficiency, particle size distribution, and energy consumption. Research findings indicate that conventional machines suffer from high vibration and blade wear, while domestic grinders are cost-effective but have limited capacity. Grinding parameters such as moisture content, speed, and feed rate significantly affect output quality. Excessive heat generation during grinding reduces the nutritional value of materials.

Advanced grinding methods such as cryogenic grinding provide better results but are expensive. Therefore, there is a need to develop low-cost, compact pulverizers suitable for rural and small-scale applications.

Methodology

A. Design Considerations

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- Motor power: 3 HP single-phase
- Grinding chamber diameter: 300 mm
- Blade material: D2 tool steel
- Frame material: Mild steel

B. Components

The machine consists of hopper, grinding chamber, rotor with blades, shaft and bearings, V-belt drive system, outlet chute, and supporting frame.

C. Fabrication Process

Frame fabrication was carried out using MS angle sections. The shaft was machined on a lathe machine. Blades were cut and heat-treated for hardness. The chamber was fabricated by rolling and welding processes. Finally, all components were assembled and aligned properly.

D. Working Principle

The machine operates on impact and shear force. Material enters through the hopper, the motor drives the shaft via V-belt, blades rotate at high speed to crush the material, and the powdered material passes through a sieve and exits via outlet.

Results and Discussion

A. Theoretical Results

- Expected efficiency: 75–85%
- Uniform particle size
- Effective power transmission

B. Practical Results

- Efficiency achieved: 70–80%
- Smooth operation with low vibration
- Good grinding quality
- Minor heat generation

C. Comparison Table

Parameter	Theoretical	Practical
Efficiency	75–85%	70–80%
Output	Fine	Fine
Vibration	Negligible	Low

The results show that the machine performs close to theoretical predictions with acceptable deviations.

V. Applications

The mini pulverizer is useful in agricultural sector for grain grinding and feed preparation, in food industries for spices and flour processing, in pharmaceutical industries for herbal powder preparation, and for rural and small-scale businesses.

VI. Conclusion

The motor-operated mini pulverizer machine was successfully designed and fabricated. It provides an efficient, economical, and user-friendly solution for grinding agricultural materials. The machine reduces manual effort while improving productivity and output quality. It is especially suitable for rural and small-scale industries.

VII. Future Scope

Future improvements may include integration of automatic feeding systems, use of stainless steel for hygienic applications, addition of dust collection systems, implementation of speed control using VFD, and development of solar-powered operation.

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OriginalArticle

A Study on the Contribution of Social Media Platforms to the Growth of Green Consumerism

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In recent years, environmental concerns and sustainability have gained significant importance, leading to the emergence of green consumerism as a vital aspect of modern consumer behavior. This research paper presents an analytical study of the role of social media in promoting green consumerism. Social media platforms have become powerful tools for communication, awareness creation, and influencing consumer attitudes toward eco-friendly products and sustainable practices.

The study examines how social media contributes to increasing environmental awareness, shaping consumer perceptions, and encouraging green purchasing behavior. It also analyzes the impact of digital campaigns, influencer marketing, and user-generated content in promoting environmentally responsible consumption. Both primary and secondary data have been considered to understand consumer preferences and the effectiveness of social media as a promotional medium.

The findings of the study indicate that social media plays a significant role in educating consumers about environmental issues and motivating them to adopt sustainable consumption patterns. However, challenges such as greenwashing, misinformation, and lack of authenticity may hinder its effectiveness. The paper concludes that while social media is a strong driver of green consumerism, strategic and ethical communication is essential to ensure long-term impact and consumer trust.

Keywords: Green Consumerism, Social Media, Sustainable Consumption, Consumer Behaviour, Environmental Awareness, Green Marketing, Eco-Friendly Products, Digital Marketing, Influencer Marketing, Purchase Intention, Sustainability, Online Consumer Engagement.

Introduction

Over the last thirty years, growing environmental issues, like climate change, pollution and exhaustion of resources have had a strong impact on the way consumers behave and created green consumerism. Green consumerism is characterized by a preference for goods and services which are environmentally friendly, sustainable and ethically produced. Consumers in urban areas such as Nagpur city have grown aware of their consumption effect on the environment and are considering alternative products that have less environmental impact (Peattie, 2010). This transformation is part of a global transformation in the direction of sustainable development and responsible consumption at the local level. Social media has been a huge revolution in the way information is produced, circulated and consumed, especially in Nagpur city with the advent of digital technology and the emergence of Facebook, Instagram, Twitter, and YouTube. These platforms have emerged as powerful tools to share information about sustainability and eco-friendly practices, empowering local businesses, environmental groups, and individuals to get the word out. Social media can be referred to as a kind of Internet-based application that allow the production and sharing of user-generated content, which in turn can be a strong tool for awareness building and social influence (Kaplan and Haenlein, 2010). Social media is key to influencing attitudes and behaviors in Nagpur as it allows for the exchange of information,



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reviews and opinions from influencers. Social media is a blended part of the promotion mix, as Mangold and Faulds (2009) pointed out; it enables consumers to communicate with brands and with one another and can impact their purchasing decision. Social media campaigns, eco-influencers and user-generated content have played a significant role in spearheading sustainable living and driving eco-friendly consumption among the residents of the city, within the framework of green consumerism. Furthermore, social media is interactive and engaging, which further promotes the involvement of consumers and builds a sense of belonging towards the environment cause in Nagpur. Research indicates that the presence of environmental content on social media is beneficial for consumers' awareness and motivation to buy green products (Joshi & Rahman, 2015). Though beneficial, the usage of social media for green consumerism in Nagpur has its challenges. Lack of authenticity, misinformation, and green washing can bring into disrepute and diminish the efficacy of sustainability communication (Delmas & Burbano, 2011). Hence, in the present study, the role of social media in promoting green consumerism in Nagpur city has been analytically investigated by analyzing its effect on consumer awareness, attitude and purchase behavior. The research aims to give insights into how social media can be used at a local level to stimulate sustainable consumption, while considering the problems with digital communication.

Literature Review

Previous research has extensively explored the relationship between consumer behavior, environmental awareness, and digital communication. According to Peattie (2010), green consumerism has evolved as a response to environmental concerns, where consumers actively seek products that are environmentally sustainable. The study highlights that increasing awareness plays a key role in shaping eco-friendly purchasing decisions.

Kotler and Keller (2016) emphasized the importance of marketing communication in influencing consumer behavior. They argued that digital platforms, particularly social media, have become essential tools for promoting sustainable products due to their wide reach and interactive nature.

A study by **Kaplan and Haenlein (2010)** defined social media as a group of Internet-based applications that enable the creation and exchange of user-generated content. Their research highlights how social media facilitates communication and engagement, making it an effective platform for spreading environmental awareness.

Research conducted by **Mangold and Faulds (2009)** found that social media significantly influences consumer decision-making by acting as a hybrid element of the promotion mix. It allows consumers to interact, share opinions, and influence each other's purchasing behavior, including preferences for green products.

According to **Joshi and Rahman (2015)**, environmental knowledge and concern are major factors influencing green purchase behavior. Their study suggests that increased exposure to environmental content through social media can positively impact consumer attitudes toward sustainable consumption.

Furthermore, a study by **Djafarova and Rushworth (2017)** highlighted the role of social media influencers in shaping consumer perceptions. Influencers who promote eco-friendly lifestyles can significantly encourage their followers to adopt green consumption practices.

Overall, the literature suggests that while social media is a powerful tool for promoting green consumerism, its effectiveness depends on the credibility, transparency, and authenticity of the information shared. There remains a need for further analytical studies to understand the extent and impact of social media influence on green consumer behavior.

Research Methodology

3.1 Research Design

The study is based on a **descriptive and analytical research design**.

3.2 Nature of Data:

- **Primary Data:** Collected through structured questionnaires from respondents.
- **Secondary Data:** Collected from research journals, books, websites, and published reports related to green consumerism and social media.

3.3 Data Collection Method: Primary data is collected using a **structured questionnaire** consisting of both closed-ended and Likert scale questions.

3.4 Sampling Technique: A **convenience sampling method** is used for this study.

3.5 Sample Size: The sample size for the study consists of **100 respondents** including students, working professionals, and general consumers who actively use social media platforms.

3.6 Area of Study: The study is conducted in **Nagpur City**, where social media usage and awareness of green products are relatively higher.

3.7 Tools for Data Analysis

1. Percentage Analysis, 2. Tables and Charts (Bar graphs, Pie charts)

3.8 Research Variables

- **Independent Variable:** Social Media
- **Dependent Variable:** Green Consumerism (consumer awareness, attitude, and purchasing behavior)

3.9 Limitations of the Study

- The study is limited to a small sample size.
- Data is based on respondents' opinions, which may be subjective.
- The study is limited to a Nagpur city only.

Objectives of the Study

1. To examine the level of awareness among consumers regarding green consumerism.
2. To assess consumer perception and trust toward green claims and sustainability messages shared on social media.
3. To provide suggestions for improving the effectiveness of social media in encouraging sustainable consumer behavior.

Hypothesis of the Study

1. **H₀ (Null Hypothesis):** social media has no significant impact on promoting green consumerism.
2. **H₁ (Alternative Hypothesis):** social media has a significant impact on promoting green consumerism.

Data Analysis and Interpretation

1. Does social media increase awareness about green consumerism?

Table 6.1

Responses	No. of Respondents	Percentage (%)
Strongly Agree	40	40%
Agree	35	35%
Neutral	15	15%
Disagree	5	5%
Strongly Disagree	5	5%
Total	100	100%

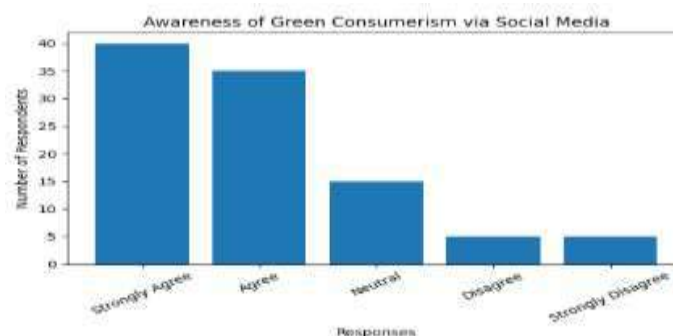


Figure 1: Awareness of green consumerism via social media

Interpretation: The above table and graph indicate that a majority of respondents (75%) agree that social media plays a significant role in increasing awareness about green consumerism.

2. Does social media influence your attitude toward eco-friendly products?

Table 6.2

Responses	No. of Respondents	Percentage (%)
Strongly Agree	38	38%
Agree	37	37%
Neutral	12	12%
Disagree	8	8%
Strongly Disagree	5	5%
Total	100%	100%

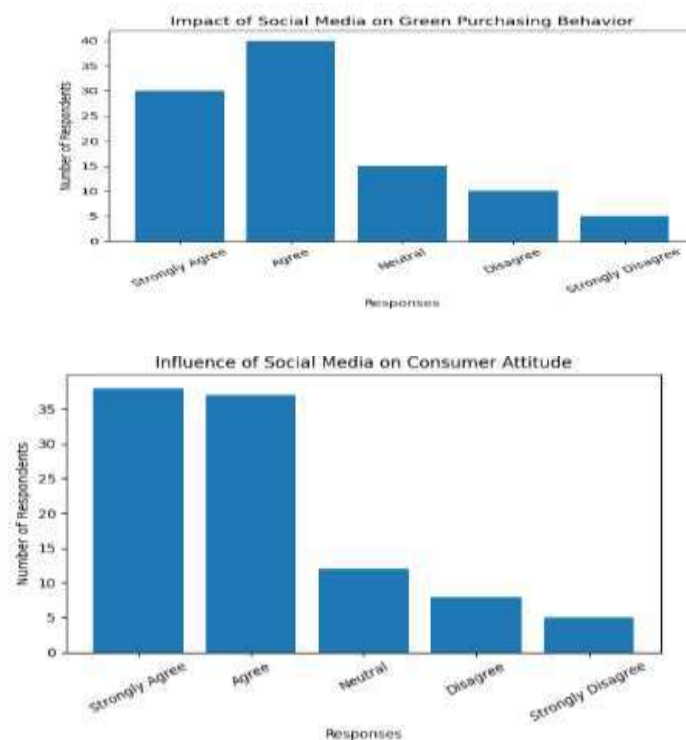
Figure 2: Influence of social media on Consumer attitude

Interpretation: A majority (75%) of respondents agree that social media positively influences their attitude toward eco-friendly products.

3.Does social media influence your purchase of green products?

Suggestions	No. of Respondents	Percentage (%)
Transparent Information	8	28%
Avoid Greenwashing	2	22%
Use of Influencers	8	18%
More Awareness Campaigns	0	20%
Interactive Content & Engagement	2	12%
Total	00	100%

Table 6.3



Responses	No. of Respondents	Percentage (%)
Strongly Agree	30	30%
Agree	40	40%
Neutral	15	15%
Disagree	10	10%
Strongly Disagree	5	5%
Total	100	100%

Figure 3: Impact of social media on green purchasing Behavior

Interpretation: Around 70% of respondents agree that social media influences their purchase of green products.

3. Which of the following do you think is the most important way to improve the effectiveness of social media in promoting sustainable consumer behavior?

Table 6.4: Consumer Opinion on Improving Social Media Effectiveness

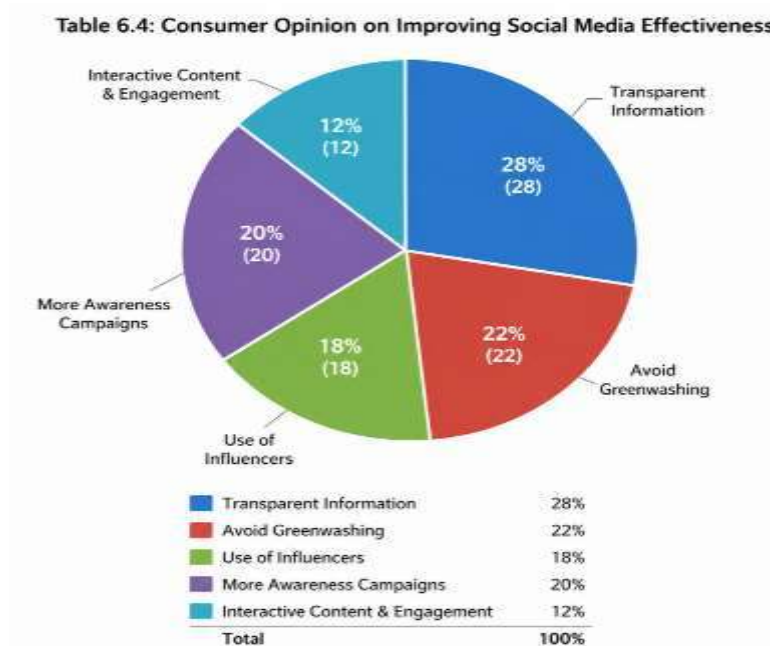


Figure 4: Consumer Opinion on Improving Social Media Effectiveness.

Conclusion

The research article “A Study on the Contribution of Social Media Platforms to the Growth of Green Consumerism” emphasizes the critical importance of social media in fostering eco-conscious consumer choices. The results show that social media platforms are very effective in raising awareness, changing attitudes and promoting the consumption of eco-friendly products among the consumers of Nagpur city.

It shows that a huge number of people feel that social media increases their awareness (75%), has a positive influence on their attitudes (75%) and affects their buying (70%). This unequivocally demonstrates that social media is informing as well as an effective enabler of behavior change towards sustainable consumption.

Moreover, the study highlights the key factors that must be addressed to build the effectiveness of social media, including information transparency (28%), avoiding greenwashing (22%) and raising awareness campaigns (20%). These results highlight how important credibility and trust is in digital communication. Yet problems with false environmental claims and lack of authenticity and levels of engagement remain. Despite these challenges, the study still shows the positive influence of social media on green consumerism. So, the alternative hypothesis (H_1) is accepted, and the null hypothesis (H_0) is rejected. In general, social media can be a powerful tool to speed up the expansion of green consumerism if utilized ethically, strategically, and transparently.



Suggestions

The following suggestions are suggested based on the findings of the study:

1. Increase Transparency: Companies should make sure they give accurate information about their products which are friendly towards the environment to increase consumer trust.
2. Don't engage in Greenwashing: Companies should make sure their environmental statements are honest and substantiated.
3. Effectively use Influencer Marketing: Partnering with credible, responsible influencers will help to market green products more authentically.
4. Enhance Awareness Campaigns: More education content and campaigns should be mounted on the social network to enhance consumer awareness of sustainability.
5. Involve consumers in the product: Brands should use interactive content, challenges and campaigns about sustainable use of the product to encourage consumers to participate.

Recommendations

1. Increase sample size: Larger and more diverse samples are needed for more accurate estimates and more generalizable results in future studies.
2. Geographical Expansion: Research can be extended beyond Nagpur and compare consumer behavior between urban and rural.
3. Individual Platforms: Future studies could examine the effects of each platform (Instagram vs YouTube).
4. Longitudinal Studies: These studies are used over a longer period to help determine changes in consumer behavior over time.
5. Policy and Regulation: Authorities should implement stricter regulations to control greenwashing and ensure authenticity in environmental claims.

Overall, the study highlights that social media can be a potent tool for driving green consumerism, but it needs to be used wisely, transparently, and credibly.

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OriginalArticle

An Analytical Study of Consumer Awareness and Adoption of Electric Vehicles in Nagpur City

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The increasing concern over environmental pollution, rising fuel costs, and the need for sustainable transportation have accelerated the adoption of electric vehicles (EVs) across the globe. This study, titled "An Analytical Study of Consumer Awareness and Adoption of Electric Vehicles in Nagpur City," aims to examine the level of consumer awareness, attitudes, and adoption behavior toward electric vehicles in the urban context of Nagpur. The research focuses on understanding how factors such as environmental awareness, government initiatives, cost considerations, and technological advancements influence consumers' decisions to adopt EVs. Primary data has been collected through structured questionnaires from respondents in Nagpur city, while secondary data has been gathered from journals, reports, and online sources. The study analyzes consumer perceptions, preferences, and the challenges faced in adopting electric vehicles.

The findings indicate that while awareness about electric vehicles is relatively high among consumers in Nagpur, the actual adoption rate is influenced by factors such as high initial cost, limited charging infrastructure, and range anxiety. However, increasing environmental consciousness and supportive government policies are positively impacting consumer interest in EVs.

The study concludes that electric vehicles have strong potential for growth in Nagpur city, provided that infrastructural and economic barriers are addressed effectively. It also highlights the need for enhanced awareness programs and policy support to accelerate the transition toward sustainable mobility.

Keywords: Electric Vehicles, Consumer Awareness, Adoption Behavior, Sustainable Transportation, Green Mobility, Environmental Sustainability, Charging Infrastructure, Consumer Perception, Urban Mobility, Nagpur City

Introduction

The need for sustainable transportation will have a significant impact with the increasing concerns over environmental degradation, air pollution and the depletion of fossil fuels. Petrol and diesel-powered traditional car manufacturers have been a significant source of greenhouse gas emissions. Due to this, electric vehicles (EVs) are gaining popularity as a more environmentally friendly and efficient mode of transport, with lower emissions. EVs are regarded as one of the effective solutions to achieve environmental sustainability and lower the carbon footprint of transportation sector (International Energy Agency [IEA], 2023). EVs have been gaining traction in India because of government policies and incentives like the Faster Adoption and Manufacturing of Electric Vehicles (FAME) scheme and state-level incentives. With the objective of lowering pollution levels and dependence on

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imported fossil fuels, the Government of India is actively encouraging EV adoption (NITI Aayog, 2023). Despite all these efforts, however, the adoption of EVs in India is still in its nascent stages, with issues including high upfront costs, inadequate charging infrastructure, and consumer awareness. The city of Nagpur has been one of the pioneers in implementing electric mobility programs at the city level. Pilot projects have been launched in the city to encourage the use of green transport, including the introduction of electric taxis, buses and charging stations. Nagpur urban consumers are slowly becoming aware of the environmental and economic advantages of EVs. But the degree of awareness, perception and action showing up varies among consumers depending on their socio-economic and infrastructural situation.

Consumer awareness is a vital factor towards EV adoption. The IEA (2023) findings indicate that consumer acceptance of EV technology is significantly affected by the increase in awareness and information. In a similar way, NITI Aayog (2023) notes that the consumer perception, affordability, and the availability of infrastructure will play a major role in deciding EV adoption in India. In addition, attitudes towards EVs are influenced by social, environmental, technological, and cost considerations. Research shows that consumers have a favorable perception of EVs, but practical implementation is restricted by battery life, charging time, and the lack of service facilities (Kumar & Alok, 2020). So, this study is intended to analyze the degree of consumer awareness and EV adoption in Nagpur city, analytically. It aims to highlight the main drivers behind consumer decisions, identify the barriers for potential EV drivers and assess consumer attitudes towards moving towards EVs. The results of this study will be helpful for policy makers, marketers and stakeholders to encourage the purchase of EVs and help to achieve sustainable urban transportation.

Literature Review

Recent studies have extensively examined the factors influencing consumer awareness and adoption of electric vehicles (EVs), particularly in developing countries like India. A study by **Higuera-Castillo et al. (2023)** found that environmental concerns, perceived usefulness, and social influence significantly impact consumers' intention to adopt electric vehicles. The research emphasized that awareness of environmental benefits plays a crucial role in shaping positive attitudes toward EV adoption.

A comprehensive systematic review by **Zaino et al. (2024)** highlighted that EV adoption is influenced by multiple dimensions, including technological advancements, government policies, environmental benefits, and infrastructure availability. The study noted that improvements in battery technology and charging infrastructure are essential in reducing consumer hesitation and increasing adoption rates.

Similarly, **Bryla et al. (2023)** conducted a systematic literature review and found that despite growing awareness of environmental issues, the adoption of electric vehicles remains relatively slow due to barriers such as high initial cost, range anxiety, and lack of infrastructure. The study also emphasized the importance of behavioral and psychological factors in influencing consumer decisions. In the Indian context, a study published in **Energy Policy (2024)** analyzed the motivators and barriers affecting EV adoption using the Behavioral Reasoning Theory (BRT). The findings revealed that personal values, environmental knowledge, and social norms significantly influence consumers' attitudes and intentions to adopt electric vehicles.

Further, research by **Kulkarni et al. (2024)** identified key determinants of EV adoption in India, including government incentives, charging infrastructure availability, environmental awareness, cost factors, and technological advancements. The study highlighted that affordability and infrastructure remain the most critical challenges in the Indian market.

Another study by **Attri and Kushwaha (2024)**, based on the UTAUT2 model, examined Indian consumers' willingness to adopt EVs and found that performance expectancy, effort expectancy, and facilitating conditions significantly affect adoption behavior. The study also emphasized the role of trust and perceived benefits in influencing consumer decisions. Moreover, an empirical study in **Transport Policy (2024)** confirmed that environmental concerns and "green nudges" positively influence consumer intention to adopt EVs. However, the study also pointed out that psychological barriers and lack of confidence in EV technology can hinder adoption.

Overall, recent literature suggests that while awareness and positive attitudes toward electric vehicles are increasing, actual adoption is still influenced by economic, infrastructural, and psychological barriers. There remains a need for localized studies, particularly in cities like Nagpur, to better understand consumer behavior and adoption patterns in specific urban contexts.

Research Methodology

This section describes the methods and procedures adopted for conducting the study titled "*An Analytical Study of Consumer Awareness and Adoption of Electric Vehicles in Nagpur City.*"

3.1 Research Design

The study is based on a **descriptive and analytical research design**. It aims to describe the level of consumer awareness and analyze the factors influencing the adoption of electric vehicles (EVs) in Nagpur city.

3.2 Nature of Data

- **Primary Data:** Collected directly from respondents through structured questionnaires.

- **Secondary Data:** Collected from research journals, government reports, websites, and published articles related to electric vehicles.

3.3 Data Collection Method

Primary data has been collected using a **structured questionnaire** consisting of closed-ended and Likert scale questions.

3.4 Sampling Technique

The study uses a **convenience sampling method**, where respondents are selected based on accessibility and willingness to participate. This method is suitable due to time and resource constraints.

3.5 Sample Size

The sample size for the study consists of **50 respondents**, including students, working professionals, and general consumers who are aware of or interested in electric vehicles.

3.6 Area of Study

The study is conducted in Nagpur, where awareness and adoption of electric vehicles are gradually increasing due to urban development and environmental concerns.

3.7 Tools for Data Analysis

- Percentage Analysis,
- Tabular Presentation,
- Graphical Representation (Bar charts, Pie charts)

3.8 Research Variables

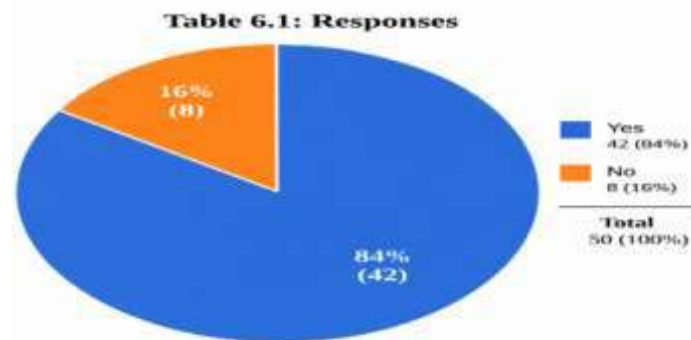
- **Independent Variable:** Consumer Awareness, Government Policies, Cost Factors, Charging Infrastructure
- **Dependent Variable:** Adoption of Electric Vehicles

3.9 Hypothesis of the Study

- **H₀ (Null Hypothesis):** Consumer awareness has no significant impact on the adoption of electric vehicles.
- **H₁ (Alternative Hypothesis):** Consumer awareness has a significant impact on the adoption of electric vehicles.

3.10 Limitations of the Study

- The study is limited to a small sample size.
- The study is limited to Nagpur only and may not represent other regions.
- Time constraints may affect the depth of the study.
- Time constraints may affect the depth of the study.



Data Analysis and Interpretation

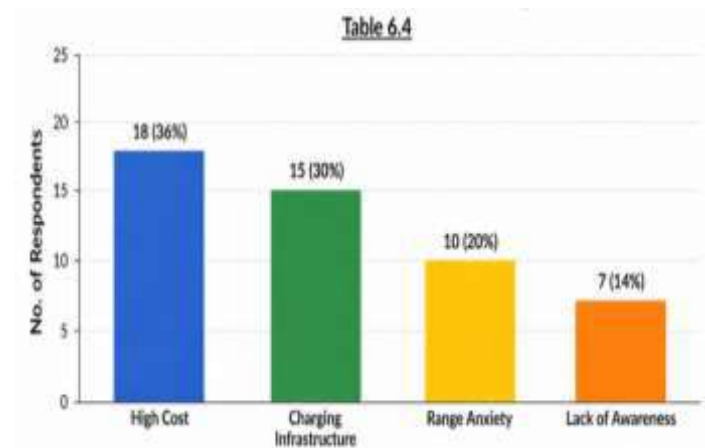
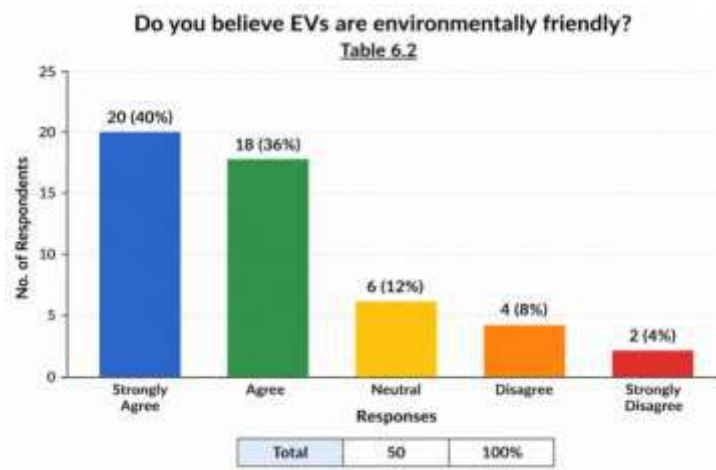
1. Are you aware of electric vehicles (EVs)?
- 2.

Responses	No. of Respondents	Percentage (%)
Yes	42	84%
No	8	16%
Total	50	100%

Interpretation: A large majority (84%) of respondents are aware of electric vehicles, indicating a high level of awareness in Nagpur city.

2. Do you believe EVs are environmentally friendly?

Responses	No. of Respondents	Percentage (%)
Strongly Agree	20	40%
Agree	18	36%
Neutral	6	12%
Disagree	4	8%
Strongly Disagree	2	4%
Total	50	100%



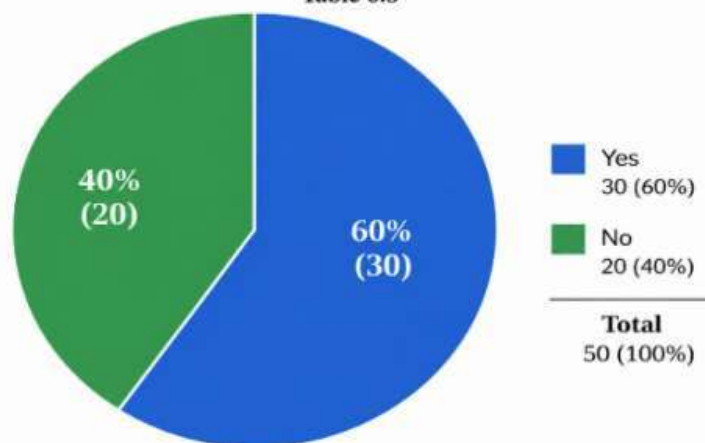
Interpretation: A majority (76%) agree that EVs are environmentally friendly, reflecting strong positive perception.

3. Are you willing to purchase an electric vehicle?

Responses	No. of Respondents	Percentage (%)
Yes	30	60%
No	20	40%
Total	50	100%

Are you willing to purchase an electric vehicle?

Table 6.3



Interpretation: 60% respondents are willing to purchase EVs, indicating moderate adoption readiness.

4.What is the main barrier to adopting EVs?

Factors	No. of Respondents	Percentage (%)
High Cost	18	36%
Charging Infrastructure	15	30%
Range Anxiety	10	20%
Lack of Awareness	7	14%
Total	50	100%

Interpretation: High cost and lack of charging infrastructure are the major barriers to EV adoption.

Conclusion

The present study titled “An Analytical Study of Consumer Awareness and Adoption of Electric Vehicles in Nagpur City” shows that consumer awareness on EVs is quite high with 84% of the total respondents being aware. This means that the public have been informed about this through awareness campaigns, media and government initiatives.

The research also reveals that the general perception of consumers is positive about EVs, with 76% of respondents saying they thought EVs were environmentally friendly. This shows the increasing awareness of green and eco-friendly consumption habits among the consumers in Nagpur city.

Nevertheless, even though awareness and attitudes are high, adoption readiness is still moderate. Only 60% of the respondents showed interest in buying an EV. This disparity between awareness and adoption suggests some practical factors that affect consumer decisions are at play.

The top barriers for electric vehicles cited are high upfront cost (36%), lack of charging stations (30%), range anxiety (20%), and lack of awareness (14%). The results here show that economic and infrastructural issues are significant barriers to EV adoption.

The overall result of the study is the presence of the strong growth potential of EV in Nagpur city. Implementing the current barriers properly can help accelerate the process towards sustainable and eco-friendly transportation. The study also supports the alternative hypothesis (H_1) – Consumer awareness has a significant influence on EV adoption.

Suggestions

The following suggestions are made on the basis of the analysis of the findings:

1. Enhancing Charging Infrastructure

Charging stations across the city must be expanded, particularly in residential neighborhoods, along highways, and in commercial districts, both public and private.

2. Lowering initial cost of EVs

Subsidies, tax breaks, and other financial incentives can help make EVs more accessible to middle-income consumers.

3. Raise awareness and conduct educational campaigns
4. Awareness is good but there is still a lack of understanding. The focus of the campaign should be on long-term cost savings, environmental benefits and technological innovation.
5. **Improving Battery Technology**
6. To address range anxiety, we need efforts to improve battery life, cut charging times and boost driving range.
7. **Strengthening Government Policies**

Schemes such as FAME and state level incentives will continue to increase EV uptake.

Recommendations

The following recommendations are suggested for policymakers, marketers, and stakeholders:

1.Policy makers: Build a strong EV ecosystem with infrastructure, incentives, and awareness initiatives. Encourage Public Private Partnerships to drive EV uptake.

2.Automobile Manufacturers: Concentrate on developing cost-effective EV models that will appeal to Indians. Fund Research and Development for better batteries and a better ride.

3.Energy and Infrastructure Sector: increase rapid charging infrastructure and guarantee electricity availability. Encourage integration of Renewable Energy and EV charging.

4.Marketers and Businesses: Emphasize the economic advantages like reduced running and maintenance costs. Employ digital marketing and social media to shape consumer perception.

5.Future Research: Perform research with larger sample sizes and spread across different cities. Delve deep into behavioral and psychological influences on EV adoption.

It is evident from the study that there are high awareness and positive perception, but adoption is largely dependent on affordability and infrastructure. These are the major challenges that need to be addressed to drive the transition towards electric mobility in Nagpur and other cities.

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OriginalArticle

Artificial Intelligence in Educational Development for Sustainability: A Study within the National Education Policy Framework in India

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Artificial Intelligence is reshaping the processes of teaching and learning, making education more accessible and tailored to individual needs. In India, the National Education Policy 2020 serves as a framework to enhance the education system, promoting the use of AI to ensure inclusivity and long-term sustainability. This study looks at how Artificial Intelligence can help make education better in India. The paper talks about tools that use Artificial Intelligence, such as systems that help students learn at their pace and systems that help teachers teach better. It also looks at projects like Skill India and Digital India that are helping to get Artificial Intelligence into all levels of education. There are also some big challenges. Access to the internet and computers is not available to everyone. Some teachers are not ready to use Artificial Intelligence in their classrooms. There are concerns regarding the protection and security of student data. This study says that we need to make sure that everyone has access to Artificial Intelligence and that we are using it in a way that's fair and safe. The study found that Artificial Intelligence can really help make India education system better. We need to be careful and make sure that we are using it in a way that is sustainable and fair. We need to work to make sure that everyone has access to Artificial Intelligence and that we are using it to make education better for all students.

Keywords: Artificial Intelligence, National Education Policy 2020 Sustainable Education, Sustainable Development Goal 4 Personalized Learning, Digital Education, Artificial Intelligence Ethics, Data Analysis, Inclusive Education

Introduction

Artificial Intelligence is changing education fast by bringing in new ways of teaching and learning. In India the National Education Policy 2020 says that new technologies are very important for making education better

The National Education Policy 2020 wants to make a system where students focus and they have the freedom to learn in their own way. This system should include everyone and also generate students' ability to think critically and creatively. Artificial Intelligence is a part of this because it helps make learning personal for each student.

There are tools like tutoring systems that can give students feedback right away which makes learning more effective. Countries such as Finland, China, and the United States have already integrated and implemented Artificial Intelligence into their education systems, with encouraging results. India also aims to adopt similar approaches, but it must address its unique challenges. At the same time, the use of AI in education brings important concerns, including the need to protect student data and ensure equitable access for all.

This study looks at how Artificial Intelligence can help with the National Education Policy 2020 and what problems might come up and it also tries to find solutions that will last. Artificial Intelligence can really support the National Education Policy 2020 if it is used in the way.

Background of the Study

Education systems worldwide are evolving due to advances in technology and globalization.

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Artificial Intelligence is one of the key innovations driving this change in education.

It has the potential to improve student learning and support more effective teaching. In India, however, the education system continues to face several challenges. Not everyone has access to education and there are big disparities between different regions. The National Education Policy 2020 is a plan to make education better. It wants to make education more flexible, multidisciplinary and technology-driven. Countries like China the United States and Finland are already using Artificial Intelligence in their education systems. They are using tools like tutoring systems and adaptive learning platforms. These tools support more effective learning among students.

Teachers teach more effectively. The United Nations has a goal to make sure that everyone has access to good education. Artificial Intelligence can play a vital role in achieving this goal by making education more accessible and tailored to individual needs. It is essential to ensure that its use remains fair, ethical, and secure.

Motivation of the Study

Artificial Intelligence can contribute to achieving this objective by enhancing access to education and enabling more personalized learning experiences. It is important to ensure that its application is responsible, equitable, and secure.

Artificial Intelligence can support the realization of this objective. The National Education Policy 2020 is a plan to make education better. It wants to make education more inclusive and sustainable. It can provide real-time feedback. Help students learn better. The world is changing fast. We must ensure that our education system is well-prepared and that students develop the skills necessary to succeed in the future. Artificial Intelligence can help make this happen. It can provide learning experiences and help students develop the skills they need. We also need to make sure that we are using Artificial Intelligence in a way that is fair and safe. We must ensure that it is accessible to everyone and used in ways that enhance education for all students.

Problem Statement

Artificial Intelligence is not being used evenly in India's education system. Some schools have access to it. Others do not. This is a problem because it means that not all students have access to the same resources. The National Education Policy 2020 is a plan to make education better. It is facing many challenges Access to the internet and computers is not universal.

Some teachers are not ready to use Artificial Intelligence in their classrooms. There are concerns about keeping student data safe. We need to make sure that we are using Artificial Intelligence in a way that's fair and safe manner. We need to make sure that everyone has access to it and that we are using it to make education better for all students. This study is trying to find a solution to this problem.

Research Gap

There are studies about Artificial Intelligence in education. We still do not know a lot of things. We do not know how Artificial Intelligence is used in India education system. We also do not know how it affects the learning of students.

Artificial Intelligence is a thing and we need to make sure it is used in a good way. We have to make sure everyone can use Artificial Intelligence and that it helps make education better, for all students.

This study is trying to find out these things. It is looking at how Artificial Intelligence's used in India education system and how it affects the learning of students. It is also looking at how to use Artificial Intelligence in an safe way. We want to make sure Artificial Intelligence is used to help all students.

Objectives of the Study

The main objectives of this research aim to develop a clear and comprehensive understanding of the integration of Artificial Intelligence in education within the framework of NEP 2020:

1. To examine the role of Artificial Intelligence in improving the quality, accessibility, and sustainability of education in India.
2. To explore the alignment between AI technologies and the goals of the National Education Policy 2020.
3. To assess the contribution of AI in achieving Sustainable Development Goal 4 (Quality Education).
4. To identify major challenges in AI adoption, including the digital divide, ethical concerns, and infrastructural constraints.
5. To suggest a conceptual framework for the sustainable implementation of AI in the Indian education system.

Literature Review

Artificial Intelligence (AI) is increasingly becoming a key component of contemporary education, transforming traditional methods of teaching and learning. It enables more personalized learning experiences, enhances student outcomes, and assists teachers in effectively managing classroom activities. Existing research highlights those AI-based tools, such as intelligent tutoring systems and educational applications, can improve both the efficiency and accessibility of education. However, scholars also emphasize the importance of responsible AI use, supported by clear guidelines to address concerns related to bias, data misuse, and lack of transparency (Holmes et al., 2024; UNESCO, 2023).

In the Indian context, the National Education Policy 2020 offers a strong framework for integrating AI into education. Despite this, several challenges remain, including inadequate digital infrastructure, unequal access to technology, and insufficient teacher training (Kumar, 2024; Dhokare, 2024). Further studies recommend that AI should be systematically incorporated into school and higher education curricula to help students build digital competencies and problem-solving skills (Aliabadi et al., 2023; van der Linde et al., 2025). Overall, while AI holds significant potential to enhance educational systems, its effective implementation depends on careful planning, ethical practices, and inclusive access for all learners (Kamalov et al., 2023; Mallik & Gangopadhyay, 2023).

Research Methodology

This study on Artificial Intelligence in Educational Development for Sustainability examines the potential of AI to improve education while promoting environmental and social sustainability. It adopts a descriptive and analytical approach, relying on secondary data rather than primary data collection. The research is based on credible sources such as the National Education Policy 2020, UNESCO reports, scholarly articles, and other relevant publications.

The collected information is categorized into major themes, including AI-driven personalized learning, policy integration, sustainability objectives, and challenges related to ethics and governance. Based on this thematic analysis, the study proposes a conceptual framework illustrating how AI can contribute to both educational development and sustainability.

As the study is theoretical in nature and does not involve empirical methods such as surveys or interviews, its conclusions require validation through future empirical research. Nevertheless, it provides valuable insights into the role of AI in shaping a more effective and sustainable education system.

Conceptual Framework

The framework of this study shows how Artificial Intelligence works with India's education system under the National Education Policy 2020 to achieve development. At the base the Artificial Intelligence layer has tools like machine learning, intelligent tutoring systems, learning analytics and adaptive learning platforms. These tools help make learning data-driven. These technologies work with the education system which includes students, teachers, schools and curriculum. Artificial Intelligence supports teaching methods, customized learning and more flexible curricula. The National Education Policy 2020 Digital India and Skill India Mission guide this interaction. They provide direction, infrastructure and focus on skill development for technology integration in education's a result we see learning outcomes equal access to education improved skill development and efficient schools. All these layers help achieve sustainability by aligning with Sustainable Development Goal 4. This goal promotes education and lifelong learning. The education system becomes adaptable, fair and sustainable in the term, with Artificial Intelligence. The education system remains strong because of Artificial Intelligence and the National Education Policy 2020. Artificial Intelligence makes education better.

Working Mechanism

Artificial intelligence processes information from schools. Gives teachers ideas that make teaching and learning better. Teachers look at the feedback from intelligence to make their classes more personal for each student and schools use the information to make good decisions.

Flow of the Model





Data → Artificial intelligence processing → Information about what students learn → Decisions about education → results → Improvement

This framework shows that artificial intelligence helps teachers and schools connect what they want to achieve with what students actually learn. Artificial intelligence is really important for making education because it helps people make good decisions, about how to teach students.

Applications of AI in Education

The use of Artificial Intelligence in education helps achieve the goals of the National Education Policy 2020. It makes learning more effective, inclusive and accessible for students.

Artificial Intelligence allows for learning experiences. It analyzes student performance.

Adjusts the content to suit their need. This way each learner progresses at their pace.

Intelligent tutoring systems act like tutors. They provide step-by-step guidance and instant feedback to students. Automated assessment tools evaluate assignments and exams quickly. - This helps reduce the workload on teachers.

Learning analytics help institutions track student progress. They identify learning gaps and provide support to students. Artificial Intelligence also improves tasks. It automates tasks like attendance and timetable management.

Artificial Intelligence makes education more accessible. It uses tools like speech-to-text to support students, with disabilities. Artificial Intelligence helps extend quality education to areas. It bridges the digital divide and supports sustainable educational development.

Discussion

The use of Artificial Intelligence in education is a big deal. It can change things for the better. It can also cause some problems. On one hand Artificial Intelligence makes things more efficient it makes learning more personal. It helps people who cannot go to school in the usual way. On the hand it raises some concerns about whether everyone has the same chance to use it if it is fair and if we have the right tools to make it work. Under the plan of the National Education Policy 2020 India is trying to make its education system better by using technologies like Artificial Intelligence. To make this work India needs to fix some problems with its infrastructure especially in areas where people live far away from cities.

Artificial Intelligence is also connected to the Sustainable Development Goal 4 which's about making sure everyone has access to education. This shows that Artificial Intelligence can really help make education fair for everyone. But there is still a problem. Some people do not have access to computers or the internet and this makes it hard for them to use Artificial Intelligence. We also need to make sure teachers are ready to use Artificial Intelligence. If they do not know how to use the tools they cannot use them in the classroom. So teachers need to keep learning things.

We have to be careful about some things too like keeping personal information safe making sure we are not watching people without their knowledge and being fair when we use algorithms to make decisions. We need to have rules in place to make sure these things do not happen. With all these problems Artificial Intelligence can do great things for education. It can help with paperwork make learning better and help people who make decisions, about education. Artificial Intelligence is really powerful. It can change education for the better.

Challenges and Future Directions

Challenges

There are gaps in digital infrastructure in rural areas We do not have educators who are trained to use Artificial Intelligence tools The cost of implementing these Artificial Intelligence tools is very high People are worried about the privacy and security of their data There are concerns about bias and fairness in the algorithms used by Artificial Intelligence Not enough research is being done in developing countries on Artificial Intelligence

Future Directions

We need to develop curriculum frameworks that include Artificial Intelligence Teacher training programs need to be expanded more educators can learn about Artificial Intelligence The government and private companies need to work to make this happen We need to build systems that make sure Artificial Intelligence is used in an ethical way More research is needed to understand how Artificial Intelligence can improve education We need to create systems that allow people to keep learning throughout their lives India must focus on building an Artificial Intelligence ecosystem that balances new ideas with making sure everyone has access, to them.

Conclusion

This study shows that Artificial Intelligence can really change the way people learn in India. It can make learning more accessible, personal and efficient. The National Education Policy 2020 is a plan and Artificial Intelligence can help make the education system better.

Artificial Intelligence is very important for making sure everyone has a chance to learn, which is part of the Sustainable Development Goal 4. Artificial Intelligence will only work if we can fix some big problems like not everyone having access to computers making sure Artificial Intelligence is used fairly and teachers are ready to use it.



The study says that Artificial Intelligence should not take the place of teachers but it should be a tool that helps teachers and students learn. We need to find a balance between using technology having the right policies and remembering what is important to people so we can make real changes, to education that will last.

Limitations of the Study

This study is mostly about ideas. Uses existing information, which makes it hard to test in real life. We did not collect our data from surveys or experiments in classrooms so our findings might not apply to everyday situations. Another problem is that AI technology is changing fast. This means our results might not be useful for as new tools and systems come out.

Our study mainly looks at the education system under the new policy introduced in 2020. This might make it hard to apply our findings to countries with different education systems. We also talk about the ethics and social effects of AI in a way without using many numbers.

For research we think it would be good to:

Do studies in schools and universities that test things out in real life.

Study how AI affects education over a long period. Compare how AI is used in education, in different countries. Measure how well students learn using AI tools.

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OriginalArticle

Gender Bias in AI-Based Recruitment Platforms: Evidence from Private Business Organization

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Artificial Intelligence (AI)-based recruitment platforms are increasingly adopted by private business organizations to enhance efficiency, objectivity, and data-driven hiring decisions. Despite these advantages, concerns regarding algorithmic gender bias have emerged as a critical ethical and managerial challenge. This study investigates gender bias perceptions in AI-based recruitment platforms within private business organizations. A quantitative research design was employed using primary data collected from 24 respondents who experienced AI-enabled hiring processes. Structured questionnaires based on a five-point Likert scale were used to examine perceptions related to fairness, transparency, usability, and gender neutrality of AI systems. The findings reveal that while AI significantly improves recruitment efficiency and standardization, respondents express moderate concerns regarding fairness and transparency, indicating the potential presence of gender bias during screening and evaluation stages. The study further identifies that human involvement remains essential in minimizing algorithmic discrimination and ensuring equitable hiring outcomes. The research recommends the adoption of hybrid recruitment models integrating AI capabilities with ethical oversight, bias auditing mechanisms, and inclusive algorithm design. The study contributes to the growing discourse on responsible AI implementation by highlighting the importance of fairness, accountability, and gender equality in technology-driven recruitment practices.

Index Terms— Artificial Intelligence, Gender Bias, AI Recruitment, Algorithmic Fairness, HR Analytics, Ethical AI

Keywords: Gender Bias, AI-Based Recruitment, Hiring Algorithms, Algorithmic Bias, Private Business Organizations, Human Resource Management, Fair Hiring Practices, Gender Equality.

Introduction

Artificial Intelligence (AI) has become an important driver of transformation in recruitment practices within private business organizations. AI-based tools such as resume screening systems, chatbots, and automated interview platforms are increasingly used to streamline hiring processes. These technologies reduce recruitment time, improve efficiency, and support data-driven decision-making.

Candidate experience is a critical factor influencing organizational attractiveness and employer branding. It refers to the perceptions and reactions of applicants throughout the recruitment process. While AI enhances operational efficiency, it also raises concerns related to transparency, fairness, and reduced human interaction. This study aims to assess gender bias perceptions with AI-based recruitment systems and understand how AI influences different stages of the hiring process.



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Objectives

1. To evaluate gender bias perceptions with AI-based recruitment
2. To analyze the role of AI in different recruitment stages
3. To assess fairness, transparency, and usability of AI systems
4. To identify the importance of human involvement in recruitment

Methodology

This study adopts a quantitative research approach using a descriptive research design to examine gender bias perceptions with AI-based recruitment in private business organizations. Primary data were collected through a structured questionnaire distributed to individuals who have experienced AI-driven recruitment processes.

A total of 24 respondents were selected using a convenience sampling technique. The questionnaire was designed using a 5-point Likert scale to measure key variables such as fairness, transparency, usability, and overall gender bias perceptions. The collected data were analyzed using descriptive statistics, including mean scores and percentages, along with correlation analysis to examine relationships between variables. The study focuses on understanding how AI influences different stages of recruitment, particularly its dominant use in initial screening and reduced use in final decision-making.

Data Analysis and Interpretation

A. Demographic Profile

Category	Frequency	Percentage
Male	14	58%
Female	10	42%

The data shows that the majority of respondents are male (58%), while female respondents constitute 42%. This indicates a relatively balanced representation, though male participants are slightly higher.

B. Experience with AI Recruitment

Response	Frequency	Percentage
Yes	24	100%

All respondents (100%) have experienced AI-based recruitment, confirming that the sample is relevant and suitable for analyzing gender bias perceptions with AI systems.

C. Perception of AI Recruitment (Likert Scale)

Statement	Mean Score
AI is easy to use	4.1
AI recruitment is fair	3.5
AI improves efficiency	4.3
AI lacks transparency	3.8
Human interaction is important	4.5

The mean scores indicate that respondents generally perceive AI recruitment as efficient (4.3) and easy to use (4.1). However, moderate scores for fairness (3.5) and transparency (3.8) suggest some concerns. The high score for human interaction (4.5) highlights its continued importance.

D. Stage-wise Use of AI in Recruitment

Recruitment Stage	AI Usage	Frequency	Percentage
Initial Screening (Filtering & Shortlisting)	High	20	83%
Mid-level Process (Assessments/Chatbots)	Moderate	15	62%
Final Selection (Interviews/Decision)	Low	6	25%

The results show that AI is predominantly used in the initial screening stage (83%), moderately used in mid-level processes (62%), and minimally used in final selection (25%). This confirms that organizations rely on AI mainly for filtering, while human involvement increases in later stages.

Interpretation

The analysis indicates that AI is widely used in the initial stages of recruitment, especially for resume screening and candidate filtering and gender-based screening considerations. However, as the recruitment process progresses, organizations rely more on traditional human-based methods, particularly during interviews and final decision-making.



This reflects the adoption of a hybrid recruitment model, where AI improves efficiency in early stages while human judgment ensures fairness and better evaluation in later stages.

Correlation Analysis

Variables	Correlation
Transparency v/s Experience	0.62
Fairness v/s Experience	0.68
Usability v/s Experience	0.71

The positive correlation values indicate that transparency, fairness, and usability have a strong relationship with gender bias perceptions. Among these, usability shows the highest influence, suggesting that ease of use plays a key role in shaping gender-related perceptions.

Results And Discussion

The findings reveal that AI significantly improves recruitment efficiency, particularly in handling large volumes of applications during initial screening. Most respondents confirmed that AI is primarily used for filtering and shortlisting candidates.

However, AI usage declines in later stages, where organizations prefer traditional recruitment methods such as interviews and human evaluation. This shift highlights the importance of human involvement in assessing soft skills, communication abilities, and cultural fit.

Although candidates appreciate the speed and convenience of AI, concerns about transparency and fairness reduce trust. Therefore, combining AI with human decision-making is essential to improve gender bias perceptions.

Findings

- AI is predominantly used in **initial recruitment stages**
- AI is effective for **resume screening and filtering**
- Traditional methods are preferred in **final selection stages**
- AI improves efficiency and usability
- Transparency and fairness remain concerns
- Candidates strongly prefer **human involvement in hiring decisions**

Conclusion

AI-based recruitment is transforming hiring practices in private business organizations. While AI enhances efficiency and simplifies early-stage recruitment processes, it cannot fully replace human judgment. The study concludes that AI is most effective in initial filtering stages, whereas traditional methods remain essential in final decision-making. A hybrid recruitment approach combining AI and human involvement is crucial for improving gender bias perceptions, trust, and organizational outcomes.

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OriginalArticle

Role of Globalisation in Sustainable Development

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Globalisation has emerged as a significant force shaping economic, social, cultural, and environmental dimensions of sustainable development across the world. It facilitates the flow of goods, services, technology, information, capital, and human resources beyond national boundaries, creating opportunities for economic growth and improved living standards. Through international cooperation, knowledge sharing, and technological innovation, globalisation contributes to achieving sustainable development goals by promoting poverty reduction, education, healthcare, and environmental awareness. However, the process also presents challenges such as economic inequality, cultural homogenisation, resource exploitation, environmental degradation, and social disparities. Sustainable development requires balancing the benefits of global integration with the protection of natural resources, social equity, and economic stability. This study examines the role of globalisation in sustainable development by analysing its positive contributions and associated challenges. It highlights the importance of inclusive policies, responsible governance, and international collaboration in ensuring that globalisation supports long-term sustainability and equitable development for present and future generations.

Keywords: Globalisation, Sustainable Development, Economic Growth, Environmental Sustainability, Social Equity, International Cooperation, Technology Transfer, Sustainable Development Goals (SDGs), Global Economy, Inclusive Development.

Introduction

The concepts of corporate social responsibility and sustainable defined broadly and often used development are interchangeably. In general, however, corporate social responsibility is often seen as a means of attaining sustainable development goals. The World Business Council for Sustainable Development defines corporate social responsibility as "the ethical behaviour of a company toward society," that is, management "acting responsibly in its relationships with other stakeholders who have a legitimate interest in the business-not just the shareholders."

Others point out that corporate citizenship is "about understanding and managing an organisation's influences on and relationships with the rest of society in a way that minimises the negative and maximises the positive." Business for Social Responsibility, an environmental interest group, considers corporate social responsibility to be "operating a business in a manner that meets or exceeds the ethical, legal, commercial, and public expectations that society has of business."

Logan, Roy and Regelbrugge point out that corporations exhibit good citizenship through at least four levels of activities: -- commercial self-interest-in which they adhere to all laws and regulations and select those activities benefiting stakeholders and communities that also directly contribute to their profitability and competitiveness in the market; -- expanded selfinterest with immediate benefits--in which they undertake activities that go beyond normal business concerns to benefit stakeholders and communities in ways that also provide measurable short- and medium-term benefits to the company;

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--- expanded self-interest with long-term benefits in which they support community activities, such as education and training, that will have important impacts on continuing business success; and

-- promoting the common good-in which they support or participate in activities that improve conditions in the community or for stakeholders with no expectation of direct tangible benefits to the company.

Tnecs Perceive Corporate Social Responsibility

Of the 25 most globalised TNCs ranked by UNCTAD in 2004, all identified and provided Internet access to reports they variously titled "corporate responsibility," "corporate social responsibility," "leadership and vision," "corporate citizenship," "sustainability," or "environmental, health and safety" reports.

Although all but four (Toyota, Honda, The News Corporation, and Hutchison Wampoa) of the top 25 non-financial TNCs ranked by the United Nations Conference on Trade and Development (UNCTAD) were US- or Western European-based companies, between 2002 and 2005 they had all issued CSR reports or documents related to social responsibility.

The CSR reports of the companies still have not reached a level of standardisation that allows easy compilation of frequency distributions of the definitions and components of corporate social responsibility. Table 1 indicates the frequency with which companies reported the activities they considered to be part of their corporate social responsibilities.

In order to be counted, the report had to address the issue rather than merely mention it and to explain how the company was carrying out its CSR activities. Clearly, the most frequently reported CSR activities were those related to legal compliance - corporate Socially oriented product/service development environmental management, health and safety standards and environmental protection.

Table 1. Corporate Social Responsibility Activities Reported

Activity	Frequency of Coverage
Corporate environmental management	21
Health and safety standards	21
Environmental protection	20
Community economic/ social development	19
Socially Oriented Product	18
Dialogue with stakeholders	18
Code of ethics/corporate behaviour	17
Maintaining/promoting diversity	17
Developing employee skills	17
Employee works standards/welfare	16
Financial accountability/transparency	16
Philanthropy/charity	16
Alternative energy use	16
Corporate governance standards	14
Human Right Principles	12
Support for employee community voluntary services	12
Supplier behaviour codes	7
Concern for consumer safety	6
Fair compensation and benefits	4
Responsible marketing standards	3
Code of fair procurement	

Most companies also reported philanthropic or charitable activities as part of their CSR strategies and included not only charitable donations but also community economic and social development projects and support for employees involved in voluntary community activities. A third most frequently reported category of CSR activities involved the development of socially-oriented products or services.

Many of the TNCs are also developing contacts and engaging in dialogues with stakeholders, both internally and externally, on corporate social responsibility standards and activities. Most companies report enhancement of employee working conditions and capabilities, diversity in the work place, and fair treatment of workers as an important part of their CSR strategies. Finally, TNCs are adopting corporate governance, ethics, fair procurement, and



financial transparency codes both in compliance with national legal requirements and as voluntary standards of business practice.

For many of the corporations their first CSR report was published only within the last three to five years. The titles of their reports often indicate the focus of their strategies, but increasingly those with more comprehensive CSR strategies are coming to define social responsibility as the combination of governance, financial transparency, environmental management, product impact, human and labour rights, employee safety, product innovation, and charitable activities.

Many of the companies follow guidelines for defining the scope of their CSR strategies and reporting established by external organisations such as the Global Reporting Initiative (GRI), the United Nations Global Compact, the Global Environmental Management Initiative (GEMI), or others. The 25 most globalised TNCs define CSR in a variety of ways, yet the coverage of the reports indicates some convergence in the perceptions of TNC executives about the most important components of CSR.

Global Tncs Formulate Their Csr Strategies

How TNCs formulate their CSR strategies or choose social responsibility activities is not always clear from their CSR reports. However, several of the companies indicate that they combine internal coordination processes with external consultation in shaping their CSR strategies and many use the guidelines developed by nonprofit organisations or international CSR monitoring and assessment groups. The French gas and electric TNC, Suez, created an Ethics, Values and Sustainable Development Coordination Unit- consisting of representatives from both management and operational units, reporting to the Executive Management Committee and to the ethics, environment, and sustainable development committee of the board of directors to develop its sustainable development strategy. The unit provides an "internal platform" for dialogue within the company's international group and with external stakeholders.

The unit's mission is to "promote the distribution of information on sound practices between the head office and subsidiaries, propose strategic directions and encourage the development of synergies." The company shapes its CSR strategy through partnerships with the Global Compact, World Business Council for Sustainable Development, CSR Europe, UNESCO, and the French committee for environment and sustainable development, Comite 21.

The German-based utilities company RWE, which serves markets throughout Europe and other parts of the world, adopted a sustainability strategy in 2003 based on four years of internal coordination and development. The company began coordinating the strategy in 1998 between its environmental protection department and its Group Headquarters after appointing a permanent staff of environment officers.

The coordination resulted in a set of environmental guidelines that were discussed and disseminated in 1999 through a group-wide transfer seminar and implemented through the adoption of the Environmental Reporting and Information System (ERIS). RWE then developed Group-wide sustainable development guidelines, conducted pilot studies during 2001 and performed environmental management reviews.

In 2002, the company adopted its future convention on sustainable development, began internal and external surveys and issued its sustainability strategy in 2003, disseminating it again through an international environmental management seminar. In 2004, RWE published its first corporate social responsibility report and implemented its group-wide auditing practices.

The Ford Motor Company used a broad process of consultation with internal managers and external organisations to develop a Code of Basic Working Conditions to protect human rights in its value chain. Ford's Code covers standards for its own divisions and for suppliers and distributors on child labour, compensation, forced labour, freedom of association, collective bargaining, working hours and verification, harassment and discrimination, and employee health and safety. Ford also developed compliance and auditing processes to enforce code standards at its own facilities and will extend the code and compliance assessments to major business partners and suppliers.

To formulate, implement and disseminate the results of its CSR strategies, General Motors - as do the vast majority of the 25 most globalised TNCs-uses a combination of stakeholder consultation.

and alignments with organisations concerned about social responsibility, including the GRI, the World Business Council for Sustainable Development (WBCSD), CSR Europe, Business for Social Responsibility (BSR), and the Coalition for Environmentally Responsible Economies (CERES). France Telecom was among the first companies to endorse and join the UN Global Compact and is a member of international industry associations that have adopted principles of sustainable and ethical development.

Tnc's Implement Csr Strategies

Among the most frequently featured in their CSR reports are efforts to green the supply chain, environmental management and protection activities, philanthropic and charitable activities.

development and introduction of socially beneficial products and services, and codes of ethics and standards of business practice.



Greening of the Supply Chain

The most globalised TNCs often report implementation of CSR policies through greening of their supply chains. KPMG found that 80 percent of the 1,600 CR reports it reviews mention supply chain issues and that 70 percent require some form of supplier declaration concerning codes of social or environmental conduct. The Ford Motor Company-as have many of the most global TNCs has certified its manufacturing facilities to ISO 14001 environmental management standards and extends environmental management standards to both its manufacturing and product development operations. Ford, along with General Motors and other major automobile manufacturers, has also required key input production suppliers to obtain ISO 14001 certification for their facilities.

Environmental Management Activities

The 25 most globalised TNCs, like the 1,600 companies surveyed by KPMG, report environmental, health and safety performance as the leading component of their CSR strategies. Toyota North America, for example, adopted an "Earth Charter" that guides its environmental management activities and corporate citizenship practices around the world. Ford also uses performance reviews of products that cover fuel economy, tailpipe emissions, materials, energy use, water use, waste generation and land use in order to reduce negative environmental impacts.

Total pursues environmental protection by helping to reduce the global economy's dependence on carbon, making the energy system more secure, and preventing negative impacts from growth. of transportation through improving automotive fuel quality and making land and maritime transportation safer. Total reports that it. practices social responsibility by curbing emissions, conserving water, reducing odor and reducing the risk of accidental pollution and by maintaining biodiversity in areas where its plants are located. General Motors is adapting its materials accounting systems, its material safety data sheet management systems, and its materials inventory control systems to generate environmental. regulatory reports and to support pollution prevention initiatives.

Philanthropic Activities

All of the most globalised TNCs, to some degree, use charitable. contributions as a cornerstone of their CSR strategies. About 74 percent of the companies in the KPMG survey reported philanthropic activities as part of their corporate social responsibility and sustainable development strategies. In 2002, for example, the Ford Motor Company made philanthropic contributions of \$84 million and between 1998 and 2002 it made charitable contributions of more than \$373 million in the United States alone. In 2003 the Ford Motor Company Fund and the corporation together made more than \$120 million in grants for community investment and engagement in the locations where it operated and supported volunteerism by employees in local communities.

General Motors entered a partnership with the Nature Conservancy to provide \$5 million over five years to help the environmental group preserve land and water ecosystems in North America, Latin America, the Caribbean, and the Asia-Pacific Region. Chevron has supported more than 1,000 employees' volunteer efforts since 1987 to restore portions of Yosemite National Park damaged by ruse by contributing more than \$600,000 to their efforts. Chevron also helps finance employee programmes in Alberta, Canada to replant more than 100,000 evergreens on land cleared for oil and gas production, and to educate teachers and students in Mississippi about wildlife and habitat preservation.

Socially Beneficial Products

An increasing number of the most globalised TNCs are also developing socially responsive products and services and assessing the social impacts of their existing products. Respo-nding to increasing interest in non-carbon-based energy, BP the British petroleum company combines new business development and socially responsible activities by diversifying into solar and wind energy generation and pursuing innovations in alternative and renewable energy technology.

Ford is developing hybrid, alternative fuel, and electric vehicles and helping to develop fuel cell programmes. Ford also uses performance reviews of products that cover fuel economy, tailpipe. emissions, materials, energy use, water use, waste generation and land use in order to reduce negative environmental impacts.

Vodafone is developing new digital radio systems in Germany for police, fire and rescue services and designing other products and services with "high social value." Vodafone also assesses the social impacts of mobile phones, including accessibility in developing countries and to lower income groups in rural areas, analyses the value added in economies and undertakes research on the health impacts of electromagnetic fields exposure on human health. ExxonMobil reports on programmes to develop advanced fuels and vehicle systems to improve fuel efficiency and to improve hydrogen production distribution for automotive fuel cell.

Standards of Business Practice

An increasing number of global corporations are adopting codes of conduct for a wide variety of activities that have a social impact. The Swiss pharmaceutical TNC, Roche, in addition to its commitment to comply with all local, national and international legislation in its operations around the world, adopted a set of corporate principles providing



guidelines on topics such as bribery, granting of advantages, dealing with third parties, receipt of gifts, conflicts of interest and remuneration of intermediaries.

The BMW Group's social responsibility strategy includes development of targeted human resource improvement programmes, guidelines for work safety and health protection, the use of efficient work structures with flexible working hours, applying internationally applicable criteria and systems for employee assessment, and paying above average "success-oriented" remuneration and benefits.

Suez, the French gas and electric TNC, has adopted a strong set of procurement principles that focus on making purchasing a shared activity involving users in the definition of needs, making procurement decisions transparent, and coordinating decisions between the group headquarters and its entities and branches. The procurement standards seek fairness and impartiality with suppliers and to avoid of conflicts of interest, ensure compliance with laws and regulations, and act consistently with the Group's commitments to sustainable development.

TnCs Report, Monitor, And Control

The corporate social responsibility and sustainable development reports of the 25 most global companies reveal some information on how these TNCs report, monitor and control the activities they claim as contributing to the public good. Companies use a combination of internal monitoring and reporting and external "social auditing" organisations.

Internal Monitoring and Reporting

General Motors focuses its monitoring and reporting on a set of key economic, environmental and social indicators. Economic indicators include revenue, earnings, dividends, vehicle sales, and global vehicle market share. Its environmental indicators include global energy use, global carbon dioxide emissions, global non-recycled waste, global water consumption, and GM sites certified to ISO 14001 (international environmental management systems standards). Social indicators include community donations and percent chose environmental issues or climate change, 23 percent health care and employee benefits, 17 percent demand for healthier or safer products and affordability of products for poorer customers, 14 percent ethical standards for advertising and marketing, 12 percent workplace conditions and safety, 11 percent demand for more ethically produced products, and 3 percent human rights standards as significant competitive factors.

On all of these socially-oriented issues, only a minority of global executives saw only or mostly opportunity and limited risk for shareholder value for companies in their industries over the next five years. Most saw either a balance between risk and opportunity or mostly risk and limited opportunity.

Nearly one-third of the executives did not believe that corporations made "a generally or somewhat positive contribution to the public good." Moreover, a majority of the executives believed that the tactics that companies in their industries used to manage social responsibility issues- media and public relations, lobbying, CEO speeches, and advertising and marketing—were ineffective.

Only 16 percent believed that publication of sustainability or corporate citizenship reports were an effective tactic. Yet, they reported overwhelmingly that the tactics believed to be most effective in their industries - increasing transparency about risks of products or processes, policies on ethics and corporate responsibility issues, and engaging stakeholders were used infrequently.

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OriginalArticle

Bioenergy and Sustainable Development

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Abstract

Bioenergy has emerged as an important component of sustainable development due to its potential to provide renewable energy, reduce dependence on fossil fuels, and support environmental conservation. Derived from organic materials such as agricultural residues, forestry waste, animal manure, and energy crops, bioenergy contributes to cleaner energy production while promoting rural development and employment opportunities. It plays a significant role in reducing greenhouse gas emissions and enhancing energy security, particularly in developing countries. The integration of bioenergy into national energy strategies can support economic growth, social well-being, and environmental sustainability. However, challenges such as land-use competition, biodiversity impacts, and sustainable biomass management must be addressed to ensure long-term benefits. This study highlights the relationship between bioenergy and sustainable development, emphasizing its contribution to achieving sustainable energy access, climate change mitigation, and inclusive economic development. The findings suggest that sustainable bioenergy practices can significantly contribute to the attainment of global sustainable development goals.

Keywords: Bioenergy Sustainable Development Renewable Energy Biomass Greenhouse Gas Emissions Energy Security Climate Change Mitigation Rural Development Environmental Sustainability Sustainable Development Goals (SDGs)

Introduction

The increased use of biomass provides diverse opportunities from a climate and development perspective. If this increase is going to be compatible with environmentally and politically sustainable development, then the conflicting and sometimes contradictory interests must be reconciled. This requires intensive dialogue, negotiations and a participatory process which includes all relevant players on a national and international level. Only then can we ensure a corresponding political framework. When the discussion of bioenergy revolves primarily around high oil prices and the scarcity of the resource oil, there is a danger of reducing bioenergy to a buffer for increased energy consumption in order to stabilize oil prices or to prevent supply interruptions. This cannot be the role of bioenergy. If bioenergy is perceived solely as an additional energy source for increasing energy consumption, new and sometimes grave problems will be created without addressing the decisive problem of climate change. Currently, particularly in the transport sector, energy consumption is still increasing steadily. Climate change caused by fossil fuel combustion and the finite supply and increased scarcity of fossil energy sources are the two key reasons why humanity will in a few decades - sooner or later be forced to phase out fossil fuels and convert to renewable energy sources. Even if coal and oil supplies were sufficient for many centuries to come - we could not afford to burn them anyway since that would destroy the climate system of the planet. The recent IPCC reports clearly show: we have underestimated the urgency of the problem, the transition to a renewable energy future is a race against time. This means: There is no alternative to a massive expansion of biomass utilization. Without it, there is no way to meet the current and future expanding energy demand, even taking into consideration all potential for increased efficiency. Almost two billion people are still waiting for initial access to modern energy services. That day will never come with a focus on fossil energies and centralized energy systems, as it has been the development strategy of most governments and multilateral development institutions so far. At the same time, the current focus on liquid biofuels such as bioethanol and biodiesel is a rather inefficient use for biomass. The greenhouse gas and energy balances for these liquid biofuels are in most cases disappointingly low and the negative side effects high. We need an open global debate about the most efficient use of biomass, in particular regarding these questions: do we need biomass to replace petroleum in the transport sector or do we focus on the best use of biomass in the whole energy mix and to reduce CO₂ emissions; what is the best mix of policies to reduce the petroleum dependence of the transport sector, in particular setting up efficient public transport systems, including, but not limited to, the use of bioenergy.

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Although, from a sustainability point of view, regional markets are preferable, there is a fast-growing world market for biomass as an energy source. Some regions are much better suited for the cultivation of bioenergy crops than others and the biomass and bioenergy materials in most cases can easily be stored and transported. For many developing countries, the export of bioenergy sources is a business opportunity that will be seized. Increasing demand will ensure a steady supply. Since there are regional differences in production costs, bioenergy sources are already being traded internationally. As long as the raw materials for bioenergy are cheaper in some countries than in others, they will be bought there despite transportation costs both environmental and monetary. The risks and side effects of this foreseeable development are of great importance for the ecosystems in the areas of production. Bioenergy production is - in principle - in competition with food production and with crops grown for material uses. Although worldwide enough food is produced to feed everyone, over 800 million people go hungry because they cannot afford to buy food. Meanwhile, the rich in industrial and developing nations have the buying power to make sure sizeable amounts of land are used to cultivate animal feed, and they buy it "processed" as meat and dairy products. This situation is transferable to bioenergy crops. When the cultivation of bioenergy crops is increasing, it will not be sufficient to simply demand that bioenergy crops must not displace food crops. If the cultivation of bioenergy crops is more lucrative for the farmer than the cultivation of food crops, which cannot be ruled out as fossil fuel prices continue to rise, farmers will cultivate them anyway. There is now increasingly a link between fossil fuel prices on the world markets with food prices. If proper policies are not put into place, then the poor may be left to compete for food not only with the livestock for the meat and dairy consumption of the rich, but also with the automobiles of the rich.

Bioenergy and Sustainability

Bioenergy is a sustainable energy source only if its entire production chain - feedstock production, refining and conversion and end use practices are sustainable. Sustainability includes environmental, social and economic considerations.

Environmental Sustainability

- **Main environmental issues:** the greatest attention has been devoted to environmental sustainability of bioenergy feedstock production. This primarily relates to the responsible use of agro-chemicals and fertilisers, waste management, prevention of soil erosion and depletion of soil nutrients, protection of biodiversity, reduction of greenhouse gas emissions, improvement of air quality, and the sustainable management of the quantity and quality of surface and groundwater. Environmental issues in refining, conversion and end use are predominantly related to GHG emissions, air quality, and water quantity and quality.
- **Biodiversity:** Two major crops used in biodiesel production pose a threat rainforest. Soy bean plantations are encroaching on forests in Brazil and palm oil plantations threaten forests in Malaysia and Indonesia. The reduction in forest habitat directly threatens species that inhabit this unique environment and diminishes other important environmental services from forests. Concerns have also been raised that rapid biofuel growth and mono-cropping practices of preferred varieties will lead to a reduction in agricultural biodiversity with negative repercussions on food security. On the other hand, the use of perennial species such as trees for bioenergy may create more favourable habitats for biodiversity compared to conventional crop production.

Social Sustainability

Challenges of traditional bioenergy:

- **Indoor air pollution** linked to traditional biomass use for cooking, counts among the major causes of ill-health and death in developing countries.
- **Time commitment:** Women in least developed countries may spend more than one third of their productive life in collecting and transporting wood. Additional help needed from children often prevents them from attending school.
- **Rural jobs and rural development:** Bioenergy is the most labour-intensive energy source. Depending on the scale of production large scale plantations, or medium and small-scale operations and on the degree of mechanisation, new employment opportunities arise for unskilled workers.
- **Labour conditions:** Labour conditions in sustainable bioenergy production should be an improvement on existing standards. Labour issues include child and forced labour, working conditions, health and safety, and adequate remuneration.
- **Gender:** Women are likely to benefit most from improved access to energy where it reduces their burden in gathering firewood and the danger from indoor air pollution. Bioenergy development and production methods should take into account differential impacts on men, women and children.
- **Access to land and water:** poor households in many developing countries do not have formal title over their land and formal rights over water. Large scale biofuel plantations can threaten their access to land and water. This also applies to marginal and degraded lands, which some countries, including India, have singled out for bioenergy development. What appears to many to be abandoned land may in fact provide important subsistence functions to the most vulnerable.
- **Economic Sustainability:** Much of current bioenergy growth is driven by policy environments and government incentives. These incentives should be targeted carefully to encourage development of bioenergy technologies that in the medium to long term are economically and commercially viable.

Bioenergy and Climate Change

Bioenergy offers significant potentials for emission reductions in electricity, heat and transportation. However, potentials vary significantly between different bioenergy technologies and regions.

- **Emission reductions must be assessed considering the full lifecycle:** The lifecycle includes production choice of feedstock, agricultural practices, land use change, etc., refining and conversion processes and end-use practices.
- **Uncertain estimates:** considerable uncertainty hampers "across the board" estimates of the potential GHG emission reductions from various biofuels. The analysis is complex because of wide variation in the use of by-products, agricultural practices in growing the feedstocks and efficiencies of processes. Reduction potentials must, therefore be seen as indicative.
- **Electricity and heat from biomass can generate greater savings than transport fuels:** biomass combustion replacing coal and oil has significant reduction potentials.



- **Biogas** from organic waste not only reduces CO₂ emissions compared to fossil fuels but also avoids methane emissions related to the decomposition of organic wastes.
- **Emission reductions from liquid biofuels:** the potential of reducing GHG emissions from liquid biofuels vary widely by region and technology. Of currently commercial technologies, Brazilian ethanol produces the largest savings - estimated to be up to 90% of GHG emissions compared to fossil fuels. Maize based ethanol production produces far lower savings, with estimates of average reductions of around 13%. 1st 2nd generation biofuels, including cellulosic ethanol, are expected to produce significant GHG savings possibly of up to 80%.

Biofuels and Sustainable Development

It is important to assess bioenergy within the overall biomass resource base and the socioeconomic context of affected communities, i.e. biomass is much too important and complex to be viewed only as a source of bioenergy. The trade-offs among the many different uses of biomass are often summarised in terms of the 4Fs: Food, Feed, Fibre, and Fuel. Even this division into four categories is much too simplified; biomass serves or impacts many inter-connected and critical functions/services, including housing, materials, maintenance of biodiversity, ecosystem integrity, nutrient cycles, water quality, erosion control, and recreation. The proper management and utilization of biomass and bioenergy also help to shape the role of citizens and communities as caretakers for resources they will pass on to future generations.

The bioenergy development strategies for particular regions should be based on socioeconomic priorities in combination with the overall resource base that is available and the subset of that resource base that can be harvested for bioenergy use. A consideration of these broader issues must include the extent to which development of biomass resources can help create, maintain, and/or expand sustainable livelihoods for the local population as well as in other areas that are connected socially, economically, and ecologically to the local or regional community or communities involved. Access to income (1998) several livelihood indicators have been identified in terms of enhancing social capital, improving the quality of work, and insuring the future availability of the natural resource base. Scoones, 1998: Creation of working days, Poverty reduction, Well-being and capabilities, Livelihood adaptation, vulnerability, and resilience and Natural resource base sustainability bioenergy generate far more jobs than any other energy source-renewable or non-renewable. Furthermore, these jobs are created mainly in rural areas where poverty is worst, and thus can help to slow down or even reverse migration to urban centres. It is harder to generalise about the impacts of bioenergy development with respect to the other four indicators. Rapid degradation of forests and soils for short-term profit will obviously not lead to sustainable livelihoods, whereas careful managed growth strategies can not only maintain the resource base but in some cases enhance it.

Promotion of Liquid Biofuels

Technology policy on the use of bioenergy in the transport sector must be re-directed. From the point of view of sustainability, promotion of liquid biofuels for road transport particularly in industrialized countries cannot be justified. The reasons for this include the high GHG abatement costs, low or negative GHG reduction potentials per unit of land or per unit of biomass used, and the lock-in effects on an inefficient infrastructure based on the combustion engine. Blending quotas should not be increased any further, and the current blending of biofuels should cease completely within the next three to four years. The road-traffic-related emissions reductions that have been agreed at EU level will then have to be achieved by other means. In the transport sector the highest energy efficiency of biomass is achieved through the generation of electricity and its use in electric vehicles. An appropriate framework for the expansion of electromobility should be developed. Promotion policies can assist businesses in their technological development by helping to expand opportunities for connection to the electricity grid. Demand for electric or hybrid vehicles can be stimulated through taxation policies.

Promotion of bioenergy for Electricity and Heat Production

Greater incentives for utilizing the potential of organic wastes and residues are created primarily through the promotion of renewables in electricity and heat production. The aim must be to promote the use of biogenic wastes and residues in such a way as to ensure that it is distinctly more attractive than the generation of electricity from energy crops. In tandem with this there is a need for appropriate regulation on the extraction of residues from agriculture and forestry, the dumping of waste and cascade uses. In some countries there is already promotion of the direct combustion of biomass primarily wood chips and pellets from residues in coal-fired and cogeneration plants and of the use of biogas, crude gas and biomethane; this should be continued and introduced as a priority in all regions in which coal plays a major part in electricity generation. However, it is essential to ensure that the biomass used meets the minimum standard with regard to sustainability. The production of electricity from biomass that meets the promotion criteria should be particularly encouraged. In addition, particular emphasis should be placed on promoting the use of biomethane if the CO₂ which is captured during the production process can be removed to secure storage. If at the same time the international scaling-up of cogeneration and combined-cycle power plants accelerates as a result of appropriate climate and energy policy measures and suitable promotional approaches, it will be possible to utilize highly efficient bioenergy pathways and hence achieve globally significant reductions in emissions. It could be viewed that it is entirely appropriate to promote the combustion of wood chips or pellets for electricity generation, but state subsidies for pure heat use should be provided in industrialized countries at most for a transition period, until a transformed energy system is in place in which this need is met from CHP plants or from heat pumps running on renewable electricity.

International Agreement on Bioenergy Subsidies

In order to cut back energy subsidies that harm the environment and give a higher priority to sustainability criteria, states need to coordinate their policies at international level. They should enter into agreements whereby non-sustainable energy subsidies are removed in all countries and guidelines for permissible subsidies, based on the principle of sustainability, are established.

Biomass as an Industrial Feedstock

In order to pave the way for strategies for the use of biomass from agriculture and forestry as a feedstock in industrial production processes, material flow analyses and land-use inventories should be drawn up both globally and nationally. The scenarios should describe likely developments competition for land use, substitution processes, etc. and options for action. For key categories of materials and products (cellulose, paper products, etc.) sustainability standards for the cultivation and extraction of



feedstocks should be set and product standards with high recycling quotas should be specified. Through suitable measures it should be possible for high levels of resource and product consumption to be greatly reduced.

Energy Poverty a Priority of Development Policy

It could be done that endeavouring to ensure that traditional forms of bioenergy use that are harmful to health are replaced by 2030. Facilitating access to modern forms of energy does not have to be included as a stand-alone goal in the Millennium Development Goals (MDGs), but it should be explicitly included in the MDGs as a means of tackling poverty and, moreover, should be more strongly anchored in the energy policy portfolios of stakeholders involved in international development cooperation. As a first step, tackling energy poverty should be systematically included in Poverty Reduction Strategy Papers. The international community should particularly promote bioenergy projects that advance rural off-grid energy supply in developing countries.

Reducing energy poverty on reliable data

So that alternative ways of providing energy services can be examined and obstacles to implementation can be better understood, actors involved in international development cooperation must work with national actors to draw up strategies for tackling energy poverty. These approaches should be based on reliable empirical findings and must be embedded in suitable policy strategies. Hence there is a need of carrying out multi-country cross-sectional evaluations and nationally, regionally and locally specific studies in order to obtain information on best practices.

Sustainable cultivation systems and the use of wastes and residues

Cultivation methods that are particularly sustainable and that help to combat soil erosion, conserve biodiversity, reduce energy poverty and advance rural development should be promoted in pilot projects. Such methods include, for example, the socially acceptable cultivation of perennial energy crops on degraded land, or agroforestry. In this context, it could be noted that the country-specific potentials of wastes and residues be assessed and then utilized in electricity generation, particularly in agro-industrial biogas plants and cogeneration plants where the waste heat is used. Pilot projects can improve the mobilization of the potential of residues and wastes.

International Renewable Energy Agency

The International Renewable Energy Agency (IRENA) is being set up with the aim of promoting worldwide use of renewable energies through policy advice, technology transfer and knowledge dissemination; this is an appropriate step towards the streamlining and institutional strengthening of international energy policy. Nevertheless, in addition to promotion of renewable energies IRENA should include all aspects of the transformation towards sustainable energy systems in its remit. It should be enabled to address aspects of energy demand and issues relating to energy, the environment and development in a comprehensive and integrated manner.

Convene an International Conference on Sustainable Bioenergy

In order to arrive at a shared global understanding of the opportunities and risks of bioenergy and a consensus on appropriate standards in relation to the production and use of different forms of bioenergy, there is a need of an International Conference on Sustainable Bioenergy be convened at an early stage. It could be used to formulate objectives and general promotion principles, exchange ideas for best-practice approaches and draw up agreements on international bioenergy partnerships and on the importance of bioenergy for a sustainable global energy system. It is important that it should bring together actors from the policy areas of agriculture, energy, the environment and development

Global Landuse Management: Inherent in the problem of competing land use, our view, is a potential for future conflict that reaches far beyond the sphere of bioenergy. Critical trends in world food security are even now becoming apparent, and they will become more acute as the world population increases to around 9 billion and land-intensive food consumption patterns become ever more widespread. Global landuse management is, therefore set to become a key future task if land-related conflicts are to be avoided.

Global Commission for Sustainable Landuse: The increasing pressure on landuse is a global challenge of an extent and complexity which is as yet little understood. This calls for the development of a complex new field. of global governance in which issues of food, energy, development, environmental and climate policy mesh. On account of the diverse global interactions and linkages involved. It will no longer possible to see landuse solely as an issue for action at individual country level. This is powerfully illustrated by the example of the worldwide effects of indirect landuse changes associated with the expansion of the bioenergy, and by the issue of equitable per capita landuse in connection with global food security.

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OriginalArticle

The Digital Script: Cyber-Feminism, Artificial Intelligence, and the Path to Sustainable Development in Maharashtra

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Abstract

In today's fast-moving world, the way we tell stories is changing, and with it, the way women find their power is changing too. In the rapidly evolving landscape of 2026, the modes of storytelling are undergoing a radical shift, and with them, the mechanisms of female empowerment. This paper examines "Cyber-feminism" not merely as a technical sub-discipline, but as a critical frontier for agency in the Age of Artificial Intelligence. For centuries, the female voice in the literary canon was systematically marginalized; however, the emergence of generative digital platforms is facilitating the creation of a new "Digital Script." The author argues that these digital narratives-ranging from vernacular micro-texts to complex AI-augmented stories-are the fundamental catalysts for gender empowerment and sustainable development. While the risk of "Algorithmic Mirroring" threatens to reinforce historical biases, the technology also offers an unprecedented opportunity to globalize regional voices, particularly within the socio-cultural context of Maharashtra. By analyzing the intersection of post-humanist theory and contemporary technology, this research demonstrates that when women achieve "Narrative Sovereignty," they contribute to a more resilient and cooperative global order. Ultimately, this study suggests that bridging the gap between literary representation and technological agency is a prerequisite for a sustainable future. By adopting the "Cyborg" identity, women transcend traditional socio-cultural boundaries, demanding that regional cooperation and corporate responsibility integrate gender-neutral algorithmic structures. In an era where code and culture are inseparable, the reclamation of the digital script is not merely an act of narration; it is a vital requirement for the equitable progress of a globalized society.

Keywords Cyber-Feminism, Digital Narratives, Artificial Intelligence, Gender Empowerment, Sustainable Development, Regional Cooperation, Narrative Sovereignty.

Introduction

For centuries, the history of women's literature has been a history of "silence and shadows." From the pseudonyms of the Brontë sisters to the marginalized voices of the domestic sphere, the female narrative has often been a struggle against the locked doors of the patriarchal canon. However, in the year 2026, the "room of one's own" that Virginia Woolf once envisioned has been superseded by a "server of one's own." As we navigate the Age of Artificial Intelligence, the traditional ink-and-paper script is being overwritten by a "digital script"-a code that possesses the dual power to either liberate or re-entrap the female voice. This paper argues that "Cyber-feminism" is the most critical literary and social movement of our globalized era. It is not merely a matter of women utilizing computational tools; it is about women becoming the architects of a new, hybrid identity. In literature, we are witnessing a transition from the biological woman to the "Cyborg"-a figure Donna Haraway famously described as a creature of social reality and fiction. By navigating cyberspace, women in regions like Maharashtra are bypassing the physical and social gatekeepers of the past, using digital narratives-from viral micro-texts to AI-integrated storytelling-to reclaim their agency. However, this new digital frontier is a "double-edged sword." While AI offers the potential to globalize local voices and foster regional cooperation, it also carries the inherent risk of "Algorithmic Bias." If the datasets fed into generative models reflect historical prejudices, the machine will simply automate the same old stories of inequality. Therefore, true sustainable development depends on more than just technological access; it necessitates "Narrative Sovereignty." This research explores how the intersection of technology and literature creates a "Nexus" of empowerment, suggesting that the reclamation of the digital script is the most effective pathway toward a sustainable, balanced, and cooperative global future. Theoretical Framework: The Cyborg and the Script The theoretical foundation of this study is rooted in the intersection of Post-humanism and Third-Wave Feminism, specifically through the lens of Donna Haraway's *A Cyborg Manifesto* (1991). Haraway introduces the "Cyborg"-a hybrid of machine and organism-as a metaphor for the modern woman who exists within a "Globalized World."



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In a traditional literary sense, the female body was often a site of biological essentialism, restricted by physical and social borders. However, the Cyborg transcends these binaries (male/female, nature/culture, creator/creature). In the age of Artificial Intelligence, this manifesto becomes a living reality; the "Cyborg" is no longer a sci-fi fantasy but a digital identity constructed through the "Script" of code and narrative.

2.1. From Gynocriticism to Cyber-criticism Traditional feminist literary theory, or Gynocriticism, sought to uncover a distinct female style in printed texts. Cyber-feminism evolves this by looking at "Digital Palimpsests"-online spaces where stories are constantly rewritten, edited, and shared. If the pen was the tool of the 19th-century woman, the Algorithm is the tool of the 21st-century woman.

The "Script" is no longer static ink; it is fluid, binary, and instantaneous. This shift allows for what N. Katherine Hayles describes as "flickering signifiers," where the digital narrative bypasses the physical gatekeepers of the traditional publishing industry.

2.2. The Narrative Nexus and Algorithmic Agency: A crucial element of this framework is the concept of the "Narrative Nexus." This is the point where human creativity meets machine intelligence. As AI begins to generate text, the role of the "Author" is redefined. For gender empowerment, this presents a unique challenge: the "Ghost in the Machine." If the AI's "Script" is trained on patriarchal data, it becomes a digital mirror of old prejudices. However, by reclaiming the script, women act as "Coders of Culture," ensuring that the AI reflects a more inclusive, sustainable development goal.

2.3. Regional Cooperation as a Networked Narrative: Finally, this framework views Regional Cooperation not as a political agreement, but as a Networked Narrative. Using the internet, women in regions like Maharashtra create a "rhizomatic" (root-like) network of stories. There is no single "center" of power; instead, there is a collective digital voice. This theoretical shift from "Individual Author" to "Networked Collective" is what makes digital narratives a powerful tool for regional stability and gender justice.

3. Artificial Intelligence: Reinforcement or Revolution? If the "Cyborg" is the identity of the modern woman, then Artificial Intelligence is the "Ghost in the Machine" that governs her digital narrative. In the context of English Literature and Sustainable Development, AI occupies a paradoxical space. It is simultaneously a tool for unprecedented globalized communication and a potential engine for the digital "re-colonization" of the female voice.

3.1. The Risk of Algorithmic Reinforcement: The primary danger of AI in the 2026 landscape is "Algorithmic Mirroring." Machine learning models are trained on vast datasets of historical human text-much of which is rooted in centuries of patriarchal bias and gendered stereotypes. When an AI "authors" a story or suggests a narrative path, it often defaults to these traditional tropes. For example, if a search algorithm or a generative text tool associates "leadership" primarily with male-centric data, it reinforces a "Glass Ceiling of Code." In this sense, AI acts as a reinforcement of the old literary canon, silencing the subversive potential of the female digital script before it can even be written.

3.2. The Revolutionary Potential of the "Polyphonic" Machine: Conversely, AI holds a revolutionary promise for Regional Cooperation and Gender Empowerment. In literature, Mikhail Bakhtin spoke of the "Polyphonic" novel-a story with many independent voices. AI can facilitate a Global Polyphony by:

- Instantaneous Translation: Breaking the "Language Barrier" that has historically isolated regional women writers in Maharashtra from the global literary market.

- Democratizing Authorship: AI tools can assist women with limited formal academic training in structuring their "Micro-narratives," turning oral histories into permanent digital records.

- Data-Driven Empowerment: By analyzing corporate and social data, AI can identify gaps in gender equality that human observers might overlook, providing a factual basis for sustainable development goals.

3.3. Corporate Responsibility and the Ethics of the Script: The transition from Reinforcement to Revolution depends entirely on Digital Ethics. Corporations that design AI have a "Corporate Responsibility" to ensure that their algorithms are "Gender-Neutral" and "Culturally Conscious." Sustainable development cannot occur if the technology driving the future is built on the prejudices of the past. As literary critics, we must analyze the output of AI not just as data, but as a new form of Electronic Literature that requires a "Cyber-feminist" intervention to ensure it serves the cause of justice rather than the status quo.

4. Case Study: Digital Micro-Narratives in Maharashtra: To understand the practical application of Cyber-feminism and Sustainable Development, one must look at the "Regional Nexus" of Maharashtra. In this landscape, the smartphone has transitioned from a communication device to a literary tool-a digital pen that allows women to bypass traditional social hierarchies. This section analyzes how "Micro-narratives" (short-form digital stories) are reshaping the identity of the Maharashtrian woman in the globalized era.

4.1. The Smartphone as a "Cyborg" Extension

In rural and semi-urban Maharashtra, the mobile phone acts as the "Cyborg" extension Haraway envisioned. For a woman in a village near Kalamb or Dharashiv, digital literacy is not just a technical skill; it is "Narrative Agency." Through platforms like WhatsApp, Instagram, and local community apps, these women are producing "Micro-texts"-oral histories, vlogs, and community reports-that challenge the "Silent Woman" trope in traditional Marathi literature. This is a form of Digital Gynocriticism, where the "lived experience" of the woman is archived in real-time, creating a regional database for sustainable social change.

4.2. Regional Cooperation through "Networked Sisterhood": A powerful example of this is the rise of digital communities such as Swayam Shikshan Prayog (SSP) and various Self-Help Groups (SHGs) across Maharashtra. These groups use digital narratives to share agricultural techniques, financial strategies, and healthcare information.

- The Literary Angle: These are not just data exchanges; they are Collaborative Scripts.

- The Impact: By sharing these stories across districts, women foster a form of Regional Cooperation that is decentralized and resilient. This aligns perfectly with the goal of Sustainable Development, as it proves that economic empowerment begins with the "Empowerment of the Story."



4.3. Subverting the Canon: From Lavani to Live-streams

Traditionally, the representation of women in Maharashtrian culture was often limited to specific folk or literary forms. Today, cyber-feminism allows for a "Subversion of the Canon." Digital narratives enable women to reclaim folk traditions (like Ovi or Lavani) and re-present them through a modern, empowered lens on global platforms. This "Digital Folklore" ensures that while the world becomes globalized, the regional soul is not lost; instead, it is amplified through the revolutionary power of the digital script.

4.4. Challenges: The Digital Divide and Language Hegemony: However, the case study also reveals a "Digital Gap." While English remains the language of the globalized elite, the true sustainable future lies in Vernacular AI. If AI tools are not proficient in Marathi nuances, the regional digital narrative remains marginalized. Therefore, Corporate Responsibility in the tech sector must focus on Local-Language AI to ensure that the women of Maharashtra are not just "users" of technology, but "authors" of the global digital future.

5. Corporate Responsibility and Digital Ethics: In the globalized economy of 2026, Corporate Responsibility (CR) has evolved from simple philanthropy to a deep-seated ethical requirement for digital governance. As tech conglomerates and regional startups increasingly dictate the "Digital Script" through AI and social platforms, the literary world must demand a new standard of Digital Ethics. If the narratives of women-especially those in developing regions like Maharashtra-are to be sustainable, corporations must move beyond "Gender Diversity" as a buzzword and treat it as a fundamental structural necessity.

5.1. Beyond Performative CSR: The Ethics of the Algorithm: For decades, Corporate Social Responsibility (CSR) often involved one-off donations or awareness campaigns. However, in the age of AI, the most significant corporate responsibility is the "De-biasing of the Code." Digital ethics require that companies actively audit their algorithms to ensure they do not reinforce the "Silencing of the Female Voice." When a corporate platform's AI prioritizes male-centric content or fails to recognize regional linguistic nuances, it commits a "Narrative Injustice." True responsibility lies in creating "Transparent AI"-where the "Script" is open to ethical scrutiny and inclusive of diverse gender perspectives.

5.2. Data Sovereignty and the Protection of the Subject: A key ethical concern in the digital narrative is the ownership of the story. Often, the "Micro-narratives" of rural women are harvested as "Big Data" by corporations without providing any reciprocal empowerment.

• The Literary Perspective: This is a modern form of "Plagiarism" or "Colonial Mapping." • The Ethical Solution: Corporations have a responsibility to uphold "Data Sovereignty," ensuring that women remain the primary beneficiaries and authors of their digital presence. Sustainable development is only possible when the "Cyborg" identity is protected from digital exploitation.

5.3. Bridging the Digital Divide as a Corporate Mandate

Regional cooperation cannot exist in a vacuum. There is a "Corporate Mandate" to close the gap between the "Globalized Tech-Elite" and the "Regional Subaltern." Digital ethics demand that corporations invest in Vernacular Technology-AI that understands Marathi, Gondi, or Varhadi as fluently as English. By providing the tools for regional women to write their own digital scripts, corporations fulfill their role in the "Global Social Contract," fostering a cooperative world where technology acts as a bridge rather than a barrier.

Conclusion

Towards a Sustainable Cyber-Future

The "Age of Artificial Intelligence" is not merely a technical revolution; it is a narrative crisis. As this paper has explored, the transition from the physical pen to the digital pixel has provided women-from global metropolises to the rural landscapes of Maharashtra-with a "Digital Script" that is fundamentally subversive. By embracing the identity of the Cyborg, women are successfully dismantling the monolithic structures of the past, replacing the silent margins of traditional literature with the vibrant, polyphonic voices of the digital frontier. However, the path to Sustainable Development is not an automated one. We have seen that technology, left unchecked, can act as a reinforcement of old patriarchal biases through "Algorithmic Mirroring." Therefore, the true revolution lies in human intervention within the code. Gender empowerment in 2026 requires more than just access to a smartphone; it requires "Narrative Sovereignty"-the right for women to author, own, and distribute their own stories without the mediation of traditional gatekeepers. For the pillars of Corporate Responsibility and Regional Cooperation, the implications are clear. Corporations must move beyond performative ethics to ensure that AI is built on inclusive, gender-neutral data. Simultaneously, regional networks must continue to foster "Digital Sisterhoods" that protect and amplify local vernacular identities. Ultimately, English Literature teaches us that whoever controls the story, controls the future. If we are to achieve a balanced, cooperative, and globalized society, we must ensure that the "Code of the Future" is written in a language of equality. The reclamation of the digital narrative is not just a literary exercise; it is the most effective strategy for the survival and flourishing of a just civilization.

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OriginalArticle

Application (Gis) In Watershed

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Geographic Information Systems (GIS) have become indispensable tools in watershed management, revolutionizing how environmental resources are monitored, analyzed, and managed. This paper explores the multifaceted applications of GIS in enhancing watershed management practices, emphasizing its role in integrating spatial data for improved decision-making and resource management. Watersheds, being complex and dynamic ecosystems, require comprehensive analysis to manage water resources effectively.

GIS facilitates this by providing a platform for spatial data integration, allowing for detailed mapping and analysis of land use, vegetation, hydrology, and soil characteristics. By leveraging GIS, watershed managers can generate accurate topographic maps, delineate watershed boundaries, and analyze hydrological patterns to predict and manage water flow and quality. One key application is in flood risk assessment and management. GIS enables the modeling of flood-prone areas by analyzing elevation data, historical flood events, and land use patterns. This helps in identifying high-risk zones and planning appropriate mitigation strategies. Additionally, GIS supports the management of water quality by integrating data on pollutant sources, land use, and hydrological pathways, allowing for the identification of contamination sources and the development of targeted intervention strategies.

GIS also enhances stakeholder engagement and public awareness by creating visually intuitive maps and interactive tools that illustrate watershed conditions and management plans. This fosters better communication between managers, policymakers, and the public, facilitating collaborative efforts in watershed conservation. Overall, the integration of GIS in watershed management provides a powerful framework for spatial analysis, enabling more informed and effective management decisions. By harnessing the capabilities of GIS, watershed managers can improve the sustainability and resilience of water resources, ultimately contributing to better environmental outcomes and community well-being.

Key words: Geographic Information Systems (GIS), resource management, watershed management practices

Introduction

Watershed management is essential for sustainable water resource management, particularly in the face of increasing environmental challenges such as climate change, urbanization, and pollution. Geographic Information Systems (GIS) play a pivotal role in watershed management by providing tools for data collection, analysis, and visualization. Watershed management is critical for maintaining the health of ecosystems and the sustainability of water resources. A watershed is defined as an area of land where all the water that falls within it drains into a common outlet, such as a river or lake. The complexity of watersheds, influenced by various factors such as topography, climate, land use, and human activities, necessitates sophisticated tools for effective management. Geographic Information Systems (GIS) have emerged as essential instruments in this context, providing capabilities for spatial data analysis and visualization that enhance decision-making processes. GIS allows for the integration of diverse datasets, including topographic maps, hydrological data, land use patterns, and environmental conditions.



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This integration is crucial for understanding the interactions within a watershed and for developing effective management strategies. This review paper explores the specific applications of GIS in watershed management, highlighting its significance in flood risk assessment, water quality management, stakeholder engagement, and overall resource management applications of GIS in watershed management, highlighting its significance in modeling hydrological processes, decision support systems, and resource management strategies.

Watershed

Watershed is a physical unit in which water from all over the area flows under gravity to a common drainage channel or watershed is defined as a geo-hydrological unit draining to a common point by a system of drains (Bai, 2018).

Types of watersheds

- Macro watershed (> 50,000 ha)
- Sub-watershed (10,000 to 50,000 ha)
- Milli-watershed (1000 to 10,000 ha)
- Micro watershed (100 to 1000 ha)
- Mini watershed (1-100 ha)

Watershed Management

Watershed Management is a term used to describe the process of implementing land use practices and water management practices to protect and improve the quality of the water and other natural sources within a watershed by managing the use of those land and water resources in a comprehensive manner (Bai, 2018).

Role of GIS in Watershed Management

GIS is a powerful tool that allows for the integration of spatial data and analysis, which is crucial in understanding complex watershed dynamics.

Data collection and integration

GIS enables the collection and integration of diverse datasets essential for watershed management. This includes:

Topographic Data

Topographic data, primarily represented through Digital Elevation Models (DEMs), is crucial for analyzing terrain and defining watershed boundaries. DEMs provide a three-dimensional representation of the Earth's surface, allowing for the assessment of water flow and accumulation patterns. This data helps in identifying watershed areas, drainage networks, and potential flooding zones. The integration of topographic data into GIS enables hydrologists and planners to simulate water movement and assess the impacts of land use changes on hydrology (Czajkowski, 2013).

Land Use and Land Cover Data

Land use and land cover data are essential for understanding the anthropogenic impacts on watersheds. Satellite imagery and aerial photography are commonly used to monitor changes in land use over time. This data is vital for assessing how different land uses—such as urban development, agriculture, and forestry—affect water quality and hydrological processes. For instance, changes in land cover can lead to increased runoff and sedimentation, which can degrade water quality. GIS facilitates the integration of this data, allowing for comprehensive analyses of land use impacts on watershed health (Czajkowski, 2013).

Soil Data

Soil data encompasses information on soil types, permeability, and erosion potential, which are critical for evaluating land suitability and managing agricultural practices. Soil maps generated through GIS provide insights into how different soil types influence water retention, drainage, and erosion rates. This information is invaluable for planning land use and implementing conservation practices to mitigate soil erosion and enhance water quality. The integration of soil data into GIS allows for detailed spatial analyses that inform effective watershed management strategies.

Holistic View and Management Strategies

The integration of topographic, land use, and soil data into a GIS framework offers a holistic view of the watershed. This comprehensive perspective enables stakeholders to identify relationships between various environmental factors and to develop informed management strategies. For example, GIS can be used to model potential scenarios for land use changes and their impacts on water resources, facilitating better planning and decision-making in watershed management (Czajkowski, 2013). GIS facilitates the collection, storage, and management of spatial data, including topography, land use, soil types, and hydrological features. This data is essential for modeling and analyzing watershed characteristics.

Hydrological modeling applications

GIS plays a critical role in hydrological modeling, which simulates the movement and distribution of water within a watershed. This modeling is essential for effective water resource management and flood control. Below are detailed insights into key applications of GIS in hydrological modeling, along with references to support these points. Runoff prediction GIS-based models, such as the Soil Conservation Service Curve Number (SCS-CN) method, are extensively used to estimate runoff based on various factors, including land use, soil type, and rainfall data. This method is particularly valuable for flood management and water resource planning, as it helps predict how much rainfall will convert to runoff in different scenarios. The integration of GIS allows for the efficient processing of spatial data, enabling hydrologists to assess potential flood risks and design appropriate mitigation strategies (Singh, 1996).

Erosion modeling

Erosion modeling is another significant application of GIS in hydrology. Tools like the Universal Soil Loss Equation (USLE) can be integrated with GIS to identify areas prone to erosion. By analyzing factors such as slope, soil type, and land cover, GIS helps target conservation efforts effectively. This capability is crucial for managing soil health and preventing sedimentation in waterways, which can degrade water quality and aquatic habitats.

Water quality assessment

GIS is instrumental in analyzing the impact of land use on water quality by modeling pollutant transport and identifying critical source areas for non-point source pollution. By integrating various datasets, such as land use maps and hydrological models, GIS allows for a comprehensive assessment of how different land uses contribute to water quality degradation. This information is vital for developing strategies to mitigate pollution and protect water resources.

Integration of spatial data

The effectiveness of hydrological modeling using GIS is largely due to its ability to integrate diverse datasets. This includes:

Digital elevation models (DEM)

Essential for understanding topography and watershed boundaries, which influence water flow and accumulation patterns.

Hydro-meteorological data

Incorporating precipitation, temperature, and other climate variables enhances the accuracy of hydrological predictions.

Land use and soil data

These datasets help model how human activities and natural soil characteristics affect water movement and quality. The integration of these datasets into GIS frameworks allows for dynamic modeling that can adapt to changing environmental conditions, making it a powerful tool for watershed management (Singh, 1996).

Spatial analysis and visualization

One of the strengths of GIS is its ability to perform spatial analysis and visualization. This includes:

Mapping and visualization

GIS allows for the creation of detailed maps that visualize watershed characteristics, such as hydrological features, land use patterns, and erosion hotspots. These maps are invaluable for stakeholders and decision-makers.

Buffer analysis

GIS can be used to create buffer zones around water bodies to assess the impact of land use changes and to plan for conservation measures.

Scenario analysis

By simulating different land use scenarios, GIS can help predict the potential impacts of development projects on watershed health, guiding sustainable decision-making.

Decision support systems

GIS serves as a foundation for decision support systems (DSS) in watershed management. These systems integrate data, models, and analytical tools to assist stakeholders in making informed decisions. Key features include:

Scenario planning

DSS can evaluate the effects of various management strategies on water quality, flood risk, and habitat preservation, helping to identify the most effective approaches.

Stakeholder engagement



GIS-based tools can facilitate communication among stakeholders by providing visual representations of data and potential impacts, fostering collaborative decisionmaking.

Regulatory compliance

GIS aids in ensuring compliance with environmental regulations by monitoring land use changes and assessing their impacts on water resources.

Applications of GIS In Watershed Management

Watershed characterization

GIS aids in the characterization of watersheds by creating detailed maps that depict various features such as drainage patterns, land use, and soil types. This information is critical for understanding the hydrological behavior of the watershed and identifying areas vulnerable to erosion and pollution. For example, a study in the Khajuri Watershed in India used GIS to sub-divide the large catchment area into smaller sub-watersheds and microwatersheds, allowing for a more detailed assessment of water resources and management strategies (Singh, 2021).

Water quality monitoring

GIS is instrumental in monitoring water quality by analyzing spatial patterns of pollutants and their sources. It allows for the integration of water quality data with land use and hydrological information to identify critical areas for intervention. For example, a study in the Ganga River Basin in India used GIS techniques to analyze land use patterns and their effects on sedimentation and pollution, guiding sustainable management practices in this vital watershed. Additionally, a web application developed using Google Earth Engine demonstrates how GIS can be used for real-time monitoring of water quality parameters such as turbidity, chlorophyll, and total suspended solids (Mijanur, 2022).

Erosion and sediment control

Using GIS, watershed managers can identify areas at high risk of erosion and develop targeted erosion control measures. GIS can analyze factors such as slope, soil type, and vegetation cover to predict erosion potential and design appropriate mitigation strategies. In the Maumee River Basin in Ohio, GIS was used to assess land cover changes and their impacts on water quality, leading to targeted conservation efforts in critical areas (Czajkowski, 2013).

Flood risk assessment

GIS is used to model flood risks by analyzing rainfall patterns, topography, and land use. This information is vital for developing floodplain management plans and implementing flood control measures. GIS-based flood risk maps help communities prepare for and respond to flooding events effectively. In the Khajuri Watershed case study, GIS was used to determine the range of disaster events like magnitudes, frequencies, depth, and velocities to prevent such warnings (Singh, 2021).

Land Use Planning

GIS supports land use planning by providing spatial analysis tools that help assess the impacts of different land use scenarios on watershed health. This includes evaluating the effects of urban development, agriculture, and conservation practices on water quality and quantity. In the Maumee River Basin project, GIS was used to annually determine land cover and crop rotations via remote sensing techniques, providing valuable information for land use planning and management (Czajkowski, 2013).

Case studies and applications of GIS in watershed management

Maumee River Basin, Ohio

In the Maumee River Basin in Ohio, GIS was used to assess land cover changes and their impacts on water quality. By analyzing spatial data on land use, soil types, and topography, researchers were able to identify critical areas within the watershed that were contributing disproportionately to water quality issues like nutrient loading and sedimentation. This information guided targeted conservation efforts, such as the implementation of best management practices (BMPs) in high-priority areas. The use of GIS enabled a more efficient and effective allocation of resources, leading to measurable improvements in water quality within the basin (Czajkowski, 2013 and Padala, 2023).

Ganga River Basin, India

GIS techniques were employed in the Ganga River Basin to analyze land use patterns and their effects on sedimentation and pollution. By integrating spatial data on land cover, soil erosion, and water quality, researchers were able to identify hotspots of environmental degradation and pinpoint the underlying causes. This information was used to develop sustainable management practices, such as promoting soil conservation measures in erosion-prone areas and improving wastewater treatment in urban centers. The use of GIS facilitated a more holistic and evidence-based approach to watershed management, leading to improved ecosystem health and reduced risks to human well-being. (Singh, 2021 and Shukla, 2018).

Watershed Restoration Projects



GIS has been widely used in various watershed restoration projects around the world. In these initiatives, GIS is employed for planning, implementation, and monitoring of restoration activities. For example, in the restoration of riparian habitats, GIS is used to identify priority areas for intervention, design appropriate restoration measures, and track the progress and effectiveness of restoration efforts over time. By providing a spatial framework for data integration and analysis, GIS has proven to be a valuable tool in enhancing the success and sustainability of watershed restoration projects. These case studies demonstrate the versatility and effectiveness of GIS in addressing complex watershed management challenges. By integrating spatial data, analyzing relationships, and facilitating targeted interventions, GIS has enabled more efficient and effective management of water resources, leading to improved ecosystem health and resilience (Singh, 2021).

Challenges and Future Directions Despite the Advantages of GIS In Watershed Management, Several Challenges Remain:

- **Data quality and availability:** The effectiveness of GIS applications depends on the quality and availability of spatial data. In many regions, data may be incomplete or outdated, limiting the accuracy of analyses.
- **Integration of social and political scales:** Current GIS-based decision support systems often focus primarily on spatial data, neglecting social and political dimensions. Future research should aim to integrate these aspects to create more comprehensive management strategies.
- **Capacity building:** There is a need for training and capacity building among stakeholders to effectively utilize GIS tools in watershed management. Enhancing technical skills will empower local communities and decision-makers to engage in sustainable practices (Singh, 2021).

Conclusion

Geographic Information Systems (GIS) have revolutionized watershed management by providing essential tools for data analysis, modeling, and decisionmaking. Its applications span various aspects of watershed management, from characterizing hydrological processes to supporting conservation efforts. As challenges persist, ongoing research and development of GIS technologies will be crucial in enhancing the effectiveness of watershed management strategies and ensuring sustainable water resource management for future generations.

This review highlights the critical role of GIS in addressing the complexities of watershed management and emphasizes the need for integrated approaches that consider both environmental and socio-political factors. GIS enables the integration of diverse datasets, such as topographic maps, land use patterns, and water quality data, providing a comprehensive understanding of watershed dynamics. By analyzing spatial relationships and modeling potential scenarios, GIS supports the development of targeted and cost-effective management strategies.

The applications of GIS in watershed characterization, assessment, planning, and restoration have demonstrated its effectiveness in addressing issues such as water scarcity, soil erosion, and water quality degradation. GIS-based tools like hydrological models and decision support systems have enhanced the decisionmaking process, enabling stakeholders to make informed choices based on scientific evidence. As the demand for water resources continues to grow, the application of GIS in watershed management will become increasingly important. Future advancements in GIS technology and methodologies will continue to shape the landscape of watershed management, fostering resilience in our water resources.

These advancements may include the integration of machine learning algorithms for improved predictive modeling, the incorporation of citizen science data for enhanced monitoring, and the development of user-friendly interfaces for better stakeholder engagement. In conclusion, GIS has revolutionized watershed management by providing a comprehensive framework for data integration, analysis, and decision-making. By leveraging the power of GIS, stakeholders can develop targeted and cost-effective strategies for addressing complex environmental challenges and ensuring the sustainable management of our water resources for present and future generations.

As the field continues to evolve, the integration of GIS with other emerging technologies and the adoption of holistic approaches will be crucial in meeting the growing demands on our water resources.

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OriginalArticle

Skills Development and Lifelong Learning for Inclusive and Sustainable Society: A Holistic Value-Based Model for 21st Century Education

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The present study examines the significance of skill development and lifelong learning in promoting inclusive growth, employability, and sustainable development in the 21st century. In the context of rapid technological advancement and changing socio-economic conditions, continuous learning has become essential for individuals to remain relevant and competitive. This paper proposes a "Model of Value-Based Lifelong Learning", integrating cognitive, emotional, digital, and ethical competencies. The study adopts a conceptual and analytical research design supported by illustrative data tables. The findings indicate that lifelong learning enhances employability, bridges skill gaps, and promotes social equity. The paper concludes with policy recommendations aligned with contemporary educational reforms.

Keywords: Skill Development, Lifelong Learning, Inclusive Education, Employability, Value-Based Education, Digital Skills

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Introduction

The concept of education has undergone a significant transformation in the 21st century. Learning is no longer confined to formal institutions but extends throughout life. Lifelong learning emphasizes continuous skill enhancement and knowledge acquisition to adapt to dynamic global changes. In countries like India, where demographic diversity and socio-economic disparities exist, lifelong learning plays a crucial role in ensuring inclusive development. The integration of skill-based education into mainstream education systems is essential to address unemployment and skill mismatch.

Objectives of the Study

To analyze the importance of skill development in modern education to examine the role of lifelong learning in employability

To identify challenges in implementing lifelong learning to propose a value-based model for lifelong learning

Research Methodology

1. Research Design: Conceptual and Analytical
2. Data Type: Secondary data and illustrative data tables
3. Sources: Policy documents, research journals, reports
4. Approach: Qualitative analysis with interpretative insights.

Conceptual Understanding

4.1 Skill Development

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Skill development refers to the process of enhancing an individual's abilities for personal and professional growth. It includes technical, soft, and digital skills.

Lifelong Learning Lifelong learning is a continuous, voluntary, and self-motivated process of acquiring knowledge throughout life. It includes formal, informal, and non-formal education.

Model of Value-Based Lifelong Learning (Proposed Model)

This study introduces a holistic model integrating five key dimensions: Dimension

Description

Cognitive Skills

Critical thinking, problem-solving Emotional Intelligence

Self-awareness, empathy Digital Competence

ICT and AI literacy Ethical Values

Integrity, responsibility

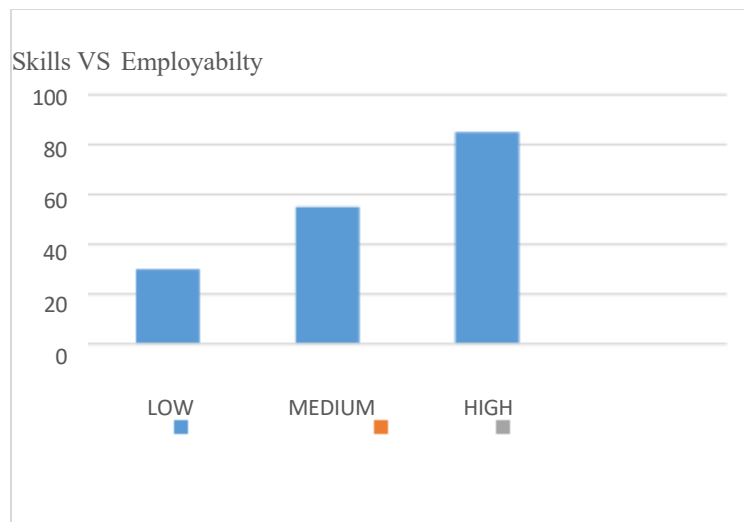
Continuous Learning Loop Ongoing skill enhancement

The model emphasizes that learning is continuous, value-driven, and multidimensional.

Data Analysis and Interpretation

Table 1: Skill Level and Employability

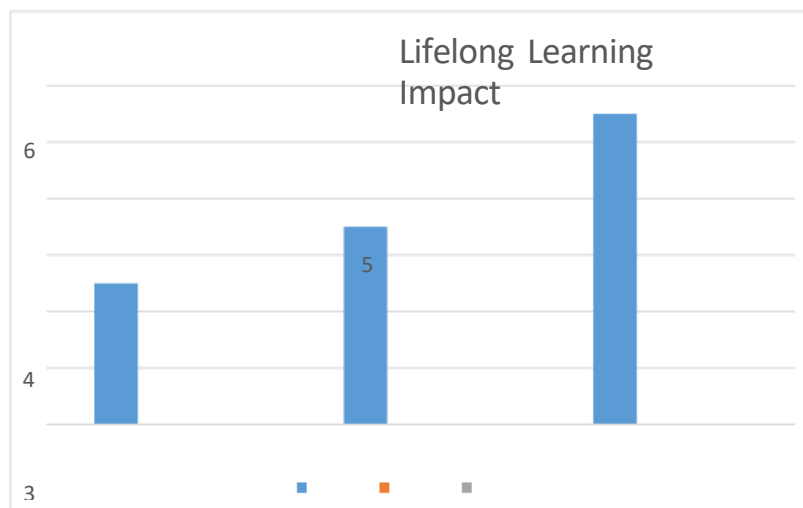
Skill Level	Employability
Low	30 %
Medium	55 %
High	85 %



Interpretation: Higher skill levels significantly improve employability prospects.

Table 2: Lifelong Learning and Career Growth

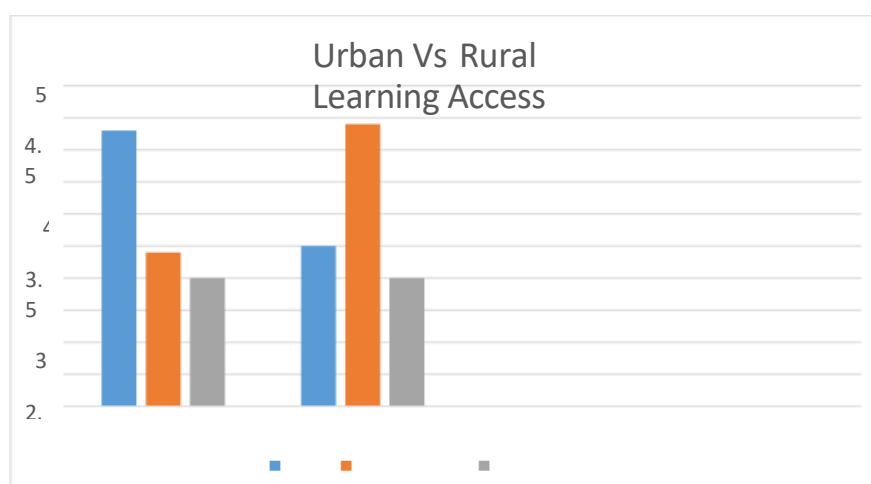
Learning Type	Career Growth
No Learning	Low
Occasional	Moderate
Continuous	High



Interpretation: Continuous learners achieve better career advancement.

Table 3: Urban vs Rural Learning Access

Area	Digital Access	Opportunities
Urban	High	High
Rural	Low	Moderate



Interpretation: There exists a digital divide affecting learning opportunities.

Case Study (Indian Context)

A comparative analysis of B.Ed students in urban and rural areas reveals disparities in digital access, exposure, and skill development. Urban students show higher adaptability to digital learning, while rural students face challenges due to limited resources.

Challenges in Lifelong Learning

- Digital divide
- Lack of awareness
- Traditional pedagogy
- Limited teacher training

Strategies and Recommendations



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Integration of skill-based curriculum Alignment with NEP 2020

Teacher capacity building

Use of AI and digital platforms

Promotion of community learning

Discussion

The findings highlight that lifelong learning is essential for bridging the gap between education and employment. It fosters adaptability, innovation, and inclusivity. The proposed model provides a structured approach to integrating values with skills.

Conclusion

Skill development and lifelong learning are fundamental for building a sustainable and inclusive society. Education systems must adopt flexible, value-based, and technology-integrated approaches to ensure holistic development.

Final Insight:

Lifelong learning is no longer optional; it is essential for survival, growth, and societal progress in the modern world.

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OriginalArticle

Financial and Administrative Challenges of Regional Development Corporations in Maharashtra

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Regional Development Corporations play a significant role in reducing regional disparities and promoting balanced socio-economic development in Maharashtra. These institutions are entrusted with the responsibility of planning, financing, and implementing development projects in backward and underdeveloped regions. However, despite their intended objectives, many Regional Development Corporations face persistent financial and administrative constraints that affect their efficiency and developmental outcomes.

This study examines the financial and administrative challenges encountered by Regional Development Corporations with special reference to Dhule District in North Maharashtra. Dhule, characterized by its predominantly rural and tribal population, presents a suitable case for understanding the practical difficulties faced in regional development initiatives. The research explores issues such as inadequate financial allocation, delays in fund disbursement, dependence on government grants, limited revenue-generation capacity, and inefficient utilization of available resources. On the administrative front, challenges including bureaucratic delays, shortage of skilled personnel, weak coordination among departments, procedural complexities, and monitoring deficiencies are analyzed. The study adopts a descriptive and analytical approach using both primary and secondary data sources. Government reports, district development plans, budget documents, and stakeholder interactions provide the basis for assessment. Findings indicate that financial constraints and administrative inefficiencies significantly hamper the timely execution of development projects, thereby affecting infrastructure development, employment generation, and socio-economic progress in the district. The study concludes that strengthening institutional capacity, ensuring timely financial support, improving transparency, enhancing inter-departmental coordination, and adopting result-oriented governance mechanisms are essential for improving the effectiveness of Regional Development Corporations. The findings may contribute to policy discussions on regional development and provide insights for improving development administration in Maharashtra's backward regions.

Keywords: Regional Development Corporation, Financial Challenges, Administrative Challenges, Dhule District, Regional Development, Maharashtra, Development Administration

Introduction

Balanced regional development is an essential prerequisite for sustainable economic growth and social justice in a diverse state like Maharashtra. Despite being one of India's most industrialized and economically advanced states, Maharashtra exhibits significant regional disparities in terms of infrastructure, employment opportunities, industrialization, agricultural productivity, and access to public services. While metropolitan regions such as Mumbai and Pune have experienced rapid economic growth, several districts in Vidarbha, Marathwada, and parts of North Maharashtra continue to face developmental challenges. To address these regional imbalances, the Government of Maharashtra established various Regional Development Corporations with the objective of promoting equitable distribution of resources and accelerating socio-economic development in relatively backward regions.

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These corporations are expected to identify local developmental needs, mobilize financial resources, implement infrastructure projects, and facilitate economic activities that contribute to regional growth. Their role has become increasingly important in the context of decentralized planning and inclusive development. However, the effectiveness of Regional Development Corporations has often been questioned due to several financial and administrative constraints. Inadequate budgetary support, delays in the release of funds, rising project costs, and limited financial autonomy have adversely affected the implementation of development programmes. Similarly, administrative challenges such as bureaucratic procedures, shortage of trained personnel, weak institutional coordination, and deficiencies in project monitoring have hindered the achievement of intended developmental outcomes.

Dhule District, located in the north-western part of Maharashtra, presents an appropriate case for examining these challenges. The district has a substantial tribal population and faces issues related to infrastructure deficits, agricultural dependence, unemployment, and uneven access to basic services. Although various developmental initiatives have been undertaken through government agencies and development corporations, the pace and effectiveness of implementation remain areas of concern. An analysis of Dhule District can therefore provide valuable insights into the practical difficulties encountered by Regional Development Corporations at the grassroots level.

The present study seeks to examine the financial and administrative challenges affecting Regional Development Corporations in Maharashtra with special reference to Dhule District. It aims to assess the nature of these challenges, evaluate their impact on developmental activities, and suggest measures for improving institutional effectiveness. The findings of the study are expected to contribute to a better understanding of regional development administration and support policy efforts aimed at achieving balanced and inclusive growth in Maharashtra.

Review of Literature

Regional development has been a significant area of academic inquiry and public policy in India, particularly in states characterized by uneven patterns of economic growth. Researchers, policy analysts, and government committees have extensively examined the role of development institutions in reducing regional disparities and promoting balanced growth. The existing literature provides valuable insights into the functioning of regional development agencies, financial management practices, administrative efficiency, and challenges affecting developmental outcomes.

One of the earliest discussions on regional disparities in Maharashtra can be traced to studies examining the uneven distribution of industrial and infrastructural development across different regions of the state. Scholars have observed that western Maharashtra benefited substantially from industrialization, irrigation facilities, and urbanization, while regions such as Vidarbha, Marathwada, and parts of North Maharashtra lagged behind in socio-economic indicators. These disparities led to the creation of specialized institutional mechanisms aimed at ensuring balanced regional development.

Research on development corporations and regional planning institutions highlights their importance in channelizing resources towards underdeveloped areas. Several studies have emphasized that such institutions serve as important instruments for implementing development projects, creating infrastructure, and supporting economic activities in backward regions. However, researchers have also pointed out that the effectiveness of these organizations largely depends on the availability of adequate financial resources and efficient administrative systems.

A number of studies focusing on public sector development agencies have identified financial constraints as a major obstacle to successful project implementation. Insufficient budget allocations, dependence on government grants, delays in fund release, and escalating project costs have been frequently cited as factors affecting organizational performance. Financial uncertainty often results in delays in project completion and limits the capacity of institutions to undertake long-term developmental initiatives.

Administrative issues have also received considerable attention in the literature. Various scholars have noted that bureaucratic procedures, lack of technical expertise, inadequate staffing, and weak coordination among government departments adversely affect development administration. Delays in decision-making and the absence of effective monitoring mechanisms often reduce the efficiency of development programmes. These challenges become more pronounced in districts with difficult geographical conditions and limited administrative capacity.

Studies related to tribal and rural development in North Maharashtra have highlighted the persistence of infrastructure deficits, educational backwardness, limited employment opportunities, and inadequate access to public services. Researchers examining districts such as Dhule and Nandurbar have emphasized that despite the implementation of various government schemes, developmental outcomes have not always matched policy expectations. Weak institutional coordination and implementation gaps have been identified as important contributing factors.

Government reports, including those prepared by planning authorities and regional development boards, have repeatedly stressed the need for strengthening institutional capacity, improving financial management, and ensuring accountability in developmental agencies. These reports suggest that transparent governance, timely fund allocation, and effective project monitoring are essential for achieving intended development objectives.



While existing studies provide substantial information regarding regional disparities and development administration in Maharashtra, limited research has specifically examined the combined impact of financial and administrative challenges on the functioning of Regional Development Corporations at the district level. Furthermore, there is a noticeable lack of focused studies on Dhule District in this context. The present study seeks to address this gap by analyzing how financial and administrative constraints influence the performance of Regional Development Corporations and their contribution to regional development in Dhule District.

The review of literature indicates that although Regional Development Corporations were established to promote balanced growth, their effectiveness continues to be influenced by structural, financial, and administrative factors. Understanding these challenges is therefore essential for improving institutional performance and ensuring inclusive regional development in Maharashtra.

Research Methodology

The present study adopts a descriptive and analytical research methodology to examine the financial and administrative challenges faced by Regional Development Corporations in Maharashtra, with special reference to Dhule District. The descriptive approach is used to understand the existing structure, functions, and operational conditions of these institutions, while the analytical approach helps in identifying the factors responsible for financial and administrative inefficiencies and assessing their impact on regional development activities.

The study is based on both primary and secondary sources of data. Primary data are collected through structured interviews and discussions with government officials, development administrators, local representatives, and beneficiaries associated with development programmes in Dhule District. Secondary data are obtained from government reports, annual reports of development corporations, budget documents, district statistical records, Maharashtra Economic Survey, research articles, books, journals, and other relevant publications.

Dhule District has been selected as the study area due to its developmental characteristics, significant rural and tribal population, and the implementation of various regional development initiatives. The study employs purposive sampling to select respondents who possess direct knowledge and experience related to the functioning of development institutions and regional development programmes.

Data collected from various sources are systematically classified, tabulated, and analyzed using descriptive statistical tools such as percentages, averages, and comparative analysis. Qualitative information obtained through interviews and documentary sources is interpreted through thematic analysis to understand the nature and extent of financial and administrative challenges. The methodology provides a comprehensive framework for assessing institutional performance, identifying operational constraints, and evaluating their implications for regional development in Dhule District. The findings derived through this methodology are expected to contribute to a better understanding of development administration and support policy measures aimed at strengthening Regional Development Corporations in Maharashtra.

Empirical Data Analysis

The empirical analysis was conducted to examine the financial and administrative challenges affecting Regional Development Corporations in Dhule District. Data collected from government officials, local representatives, development personnel, and beneficiaries revealed several issues influencing the effectiveness of development programmes. The findings indicate that inadequate financial resources and delays in fund allocation are major obstacles to the timely implementation of development projects. Dependence on government grants and limited financial autonomy further restrict the ability of development institutions to undertake new initiatives.

The study also identified significant administrative challenges, including bureaucratic delays, shortage of skilled personnel, weak inter-departmental coordination, and inadequate monitoring mechanisms. These factors often result in delays in decision-making and reduce the efficiency of project execution.

Overall, the analysis suggests that both financial constraints and administrative inefficiencies adversely affect the performance of Regional Development Corporations in Dhule District. Strengthening financial management, improving administrative capacity, and enhancing coordination and accountability mechanisms are essential for achieving effective and sustainable regional development.

Table 4.1: Category of Respondents

Category	Number of Respondents	Percentage (%)
 Government Officials	25	25%
 Local Representatives	20	20%
 Development Functionaries	30	30%
Beneficiaries	25	25%
Total	100	100%

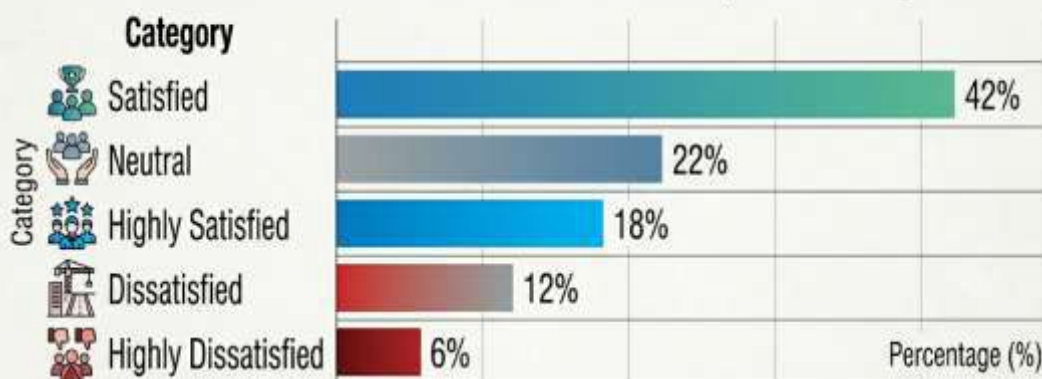
Interpretation: Development functionaries (30%) constitute the largest group of respondents, followed by government officials (25%), local representatives (20%), and beneficiaries (20%) complete the survey pool.

Table 4.2: Impact of Development Projects

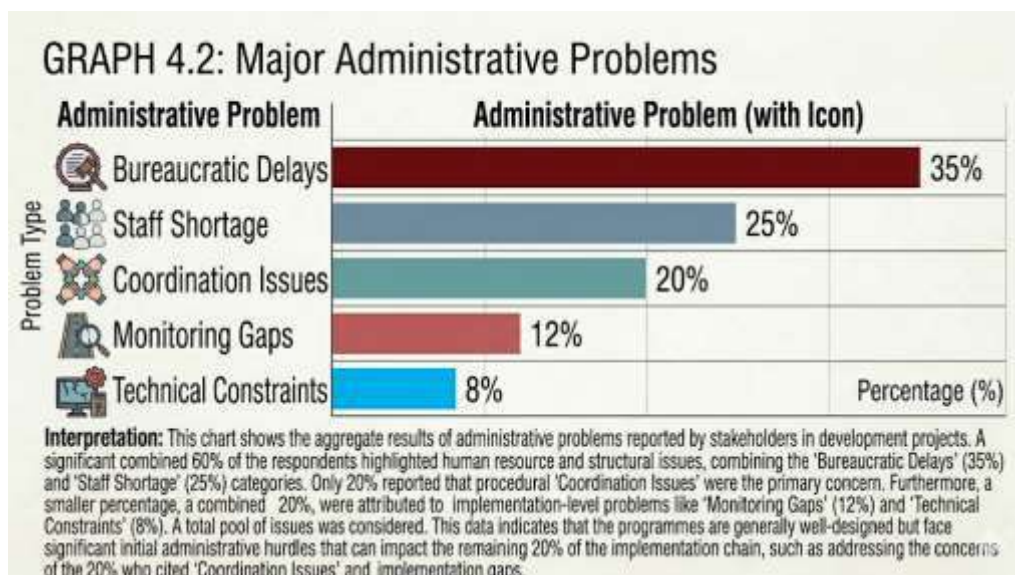
Category	Number of Respondents	Percentage (%)
 Infrastructure Development	40	40%
 Employment Generation	25	25%
 Educational Improvement	20	20%
 Healthcare Services	15	15%
Total	100	100%

Interpretation: The survey indicates that infrastructure development was the most significant impact area of the development projects, cited by 40% of respondents. Employment generation (25%), educational improvement (20%), and healthcare services (15%) also received positive feedback.

GRAPH 4.1: Satisfaction Level with Development Programmes



Interpretation: This chart shows the aggregate satisfaction levels of respondents with the development programmes. A significant 60% of the respondents expressed positive satisfaction, combining the 'Satisfied' (42%) and 'Highly Satisfied' (18%) categories. Only 18% reported negative feedback, with 12% 'Dissatisfied' and 6% being 'Highly Dissatisfied'. A notable 22% remained neutral. This data indicates that the programmes are generally well-received, but still leave room for addressing the concerns of the 18% dissatisfied participants.



Major Findings of the Study

The study reveals that Regional Development Corporations play an important role in promoting balanced regional development in Maharashtra. However, their performance is significantly influenced by financial and administrative challenges.

The findings indicate that inadequate financial resources remain a major obstacle to the effective implementation of development projects. Delays in the release of funds and excessive dependence on government grants often affect project completion and reduce operational efficiency. The study further shows that limited financial autonomy restricts the ability of development institutions to respond promptly to local developmental needs. As a result, several projects experience delays and cost escalations. On the administrative side, bureaucratic procedures and lengthy approval processes were found to be major challenges. These factors slow down decision-making and affect the timely execution of development programmes.

The research also highlights the shortage of skilled and technical personnel in development institutions. Inadequate human resources reduce the effectiveness of planning, implementation, and monitoring activities.

Another important finding is the lack of effective coordination among government departments and implementing agencies. Weak coordination often leads to delays, duplication of efforts, and inefficient utilization of resources.

The study further reveals that monitoring and evaluation mechanisms are not sufficiently strong in many cases. Limited supervision and accountability affect transparency and the overall performance of development initiatives.

Overall, the findings suggest that financial constraints and administrative inefficiencies continue to hinder the effectiveness of Regional Development Corporations in Dhule District, thereby affecting the pace of regional development.

Conclusion

Regional Development Corporations were established with the objective of reducing regional disparities and ensuring balanced socio-economic development across different regions of Maharashtra. The present study examined the financial and administrative challenges affecting the functioning of these institutions with special reference to Dhule District. The study found that inadequate financial resources, delays in fund allocation, and dependence on government grants continue to affect the effective implementation of development projects. These financial limitations often result in delays in project execution and restrict the capacity of institutions to address local developmental needs efficiently.

The study also revealed that administrative challenges such as bureaucratic procedures, shortage of skilled personnel, weak coordination among departments, and inadequate monitoring mechanisms reduce institutional effectiveness. These issues adversely influence planning, implementation, and evaluation processes, thereby limiting the overall impact of development programmes. Despite these challenges, Regional Development Corporations remain important instruments for promoting infrastructure development, employment generation, and social welfare in backward and underdeveloped regions. Strengthening financial management systems, improving administrative efficiency, enhancing accountability, and ensuring timely allocation of resources can significantly improve their performance.

In conclusion, the success of regional development initiatives depends not only on the availability of financial resources but also on effective governance and efficient administration. Addressing the identified challenges will help Regional



Development Corporations contribute more effectively towards achieving balanced, inclusive, and sustainable development in Dhule District and Maharashtra as a whole.

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Primary Source

Shinde, Pranav. (2026). Primary Data collected through field survey, interviews, and questionnaires from government officials, local representatives, development functionaries, and beneficiaries in Dhule District, Maharashtra.

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OriginalArticle

“The Impact of Skill Development Programs in Higher Education Institutions (HEIs) for Sustainable Development in India”

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Skill development programs in Higher Education Institutions (HEIs) play a important role in strengthening sustainable development in India. HEIs are shifting from traditional education models to skill-based learning approaches (Jafarov, 2025) due to increasing demand for industry-relevant skills. This paper mainly focuses on the impact of skill development programs in HEIs on economic growth, employability, social integration, and environmental sustainability. The study is based on secondary data from research papers from reputed journals, policy documents, and academic literature. Findings reveal that skill development in HEIs programs significantly promoting employability and contribute to sustainable development. Still challenges such as skill discrepancy, infrastructure gaps, and quality issues persist (Chaurasia & Punnam, 2025). The paper infers with suggestions for improving the effective implementation of skill development programs in Indian HEIs.

Keywords: Skill development, Higher Education Institutions, Sustainable Development, Employability, India, NEP 2020

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Introduction

Higher Education Institutions (HEIs) are catalysts of sustainable development as they produce required skilled human capital for economic and social progress. (Journal of Cleaner Production, 2019). In India, the traditional education system has been largely theoretical which leads the result in a gap between academic knowledge and industry requirements (Sachan, 2016). To resolve this issue, skill development programs have been introduced in HEIs to increase employability and align education with market needs (Behera & Gaur, 2022). These programs include vocational training, internships, apprenticeships, and industry collaborations. The introduction of the National Education Policy (NEP) 2020 has further focused on skill-based education, interdisciplinary learning, and innovation in HEIs (Kushawah, 2024). This has helped the growing importance of skill development in achieving sustainable development goals.

Objectives of the Study

- To analyze the role of skill development programs in HEIs
- To examine their impact on sustainable development in India
- To identify challenges in implementing skill development programs
- To suggest improvements for effective implementation

Research Methodology

This study is based on **secondary data analysis**, using research articles, government reports, and academic publications (Cabral & Dhar, 2019). A descriptive and analytical approach has been adopted to examine the relationship between skill development and sustainable development.



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Literature Review

The relationship between skill development and sustainable development has been widely studied in academic research. Cabral and Dhar (2019) found that skill development is a need to focus on unemployment and improving economic productivity in India. Behera and Gaur (2022) focused on In India, there is a significant gap between academic education and industry requirements. They are suggesting the need for vocational training and industry-oriented education.

Singh (2016) elaborated as sustainable development is a multidimensional concept involving economic, social, and environmental aspects and highlighted the importance of human capital development.

Suryavanshi and Agrawal (2024) found the significant improvement in income levels and employment opportunities in rural areas due to skill development programs.

Das (2024) focused attention on the role of skill development in empowering marginalized communities and improving access to employment opportunities.

Priya et al. (2024) drew the inference as digital technologies explore accessibility and effectiveness of skill development programs.

Conceptual Framework

Skill Development in HEIs

in HEIs, Skill development includes technical training, soft skills, digital literacy, and entrepreneurial competencies, which are essential for improving employability (Jafarov, 2025).

Sustainable Development

Economic, social, and environmental dimensions are considered in Sustainable development, and education and HEIs plays a vital role in achieving these goals (Singh, 2016).

Impact of Skill Development Programs in HEIs

- **Impact on Employability** - Skill development programs are providing practical knowledge, industry exposure to students and make them ready for job acquisition. (Chaurasia & Punnam, 2025). Studies shows that skilled based trained graduates have higher employability than those of with only theoretical knowledge (Behera & Gaur, 2022).
- **Economic Development** - A skilled human capital contributes to productivity, innovation, and competitiveness, leading to economic growth (Jafarov, 2025). HEIs play a critical role in supplying industry-ready professionals.
- **Social Integration** - Skill development programs promote inclusivity by providing opportunities to women, rural youth, and marginalized communities (Das, 2024). This helps reduce inequality and supports inclusive growth.
- **Environmental Sustainability** - HEIs encourage sustainability by including green skills and environmental awareness into their curriculum (Journal of Cleaner Production, 2019).
- **Innovation and Entrepreneurship** - Skill-based education promote innovation and entrepreneurship, which are essential for job creation and sustainable economic development (Kushawah, 2024).

Government Policies Supporting Skill Development in HEIs

- **National Education Policy (NEP) 2020** - NEP 2020 focuses on skill-based education, interdisciplinary learning, and innovation (Kushawah, 2024).
- **Skill India Mission** - This initiative emphasises on enhancing employability through skill training and workforce development (Cabral & Dhar, 2019).
- **UGC Initiatives** -The University Grants Commission promotes vocational courses and skill-based programs in HEIs (Sachan, 2016).

Challenges in Skill Development in HEIs

Major challenges are skill gaps, lack of infrastructure, and quality issues in training programs (Behera & Gaur, 2022). Weak industry-academia collaboration limits the effectiveness of skill development initiatives (Cabral & Dhar, 2019). Continuous curriculum updates also require due to rapid changes in technological development (Priya et al., 2024).

Opportunities and Future Scope

Emerging technologies such as artificial intelligence (AI) and digital platforms offer new opportunities for skill development (Priya et al., 2024). There is also growing demand for green skills and sustainable practices (Journal of Cleaner Production, 2019). HEIs can play a important role in preparing students for these future challenges.

Recommendations

- Strengthen industry-academia collaboration (Cabral & Dhar, 2019)
- Regularly update curriculum (Behera & Gaur, 2022)
- Improve infrastructure and training quality (Sachan, 2016)
- Promote digital and green skills (Priya et al., 2024)
- Ensure inclusive access to skill development (Das, 2024)



Conclusion

Skill development programs in HEIs play a significant role in promoting sustainable development in India by promoting employability, economic growth, and social integration (Jafarov, 2025). Despite of this progress, challenges such as skill gaps and quality issues (Behera & Gaur, 2022) can be addressed through effective policies and this collaboration will help HEIs to contribute significantly to sustainable development.

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Women in Small-Scale Fisheries in India: A Review of Their Socio-Economic Contributions

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Women play an important role in India's fisheries sector, contributing meaningfully across the fisheries value chain. Women are working almost in every sector of fisheries in India such as harvesting, marketing, net mending, household and livelihood management. It will be helpful in household incomes, food security and the socio-economic well-being of society. But their contributions are unrecognised in official statistics and overlooked in while making governance frameworks and policies. This review paper discuss about women are not purely supportive participants but key economic actors whose activities contribute suggestively to fisheries production, value addition, and community flexibility. Women's cooperatives, self-help groups are recently developed for women empowerment. Furthermore, the growing emphasis on sustainable fisheries and the blue economy present opportunities to support women's roles in fisheries. Women in fisheries are considered as they play a supportive role but their contributions extend far beyond. Their work plays an important role not only maintaining household incomes but also gives food and nutritional security which will give support to the complete security to fishing communities. In spite of these imperative contributions, women are facing number of social and economic challenges such as possession of assets, entree in markets, professional health anxieties, restricted connection, lack of participation in policy making and governance. The review highlights on valuing women's and acknowledging informal contributions, establishment the collection of gender-disaggregated data, providing open-minded entree to resources and chances, and fostering complete decision-making processes are critical for progressing gender equity, encouraging sustainable fisheries, and supporting the long-term growth of India's blue economy.

Keywords: Women, Small-Scale Fisheries, Gender Equality, Fisheries

Introduction

Small-scale fisheries play remarkable role for livelihood in Indian communities, which will provide direct and indirect employment to many peoples by fishing, processing and transportation. Women, s play noteworthy parts in various sector, in both economic production and household responsibilities. However, traditionally fisheries industries is male dominating industry. Catching fish is a main task in fisheries which is done by men while substantial work is done by women almost entire supply chain was controlled by women. (Bennett, 2005; Harper et al., 2013). In Indian fishing communities, women involve in a various range of post-harvest and auxiliary activities, including fish preservation through drying and curing processes, crustacean processing, quality assessment, pre-market preparation that is cleaning, retail distribution, manual transportation, fishing gear fabrication and maintenance that is net making and repair, mollusc harvesting which includes shell collection, marine macroalgae cultivation and processing, aquaculture operations support, and local economic government. Across numerous coastal and domestic fishery-reliant on regions, women function as dangerous market mediators, which simplifying the supply chain between fish landing sites and end customers at the society level.

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This transitional role ensures the approachability of profitable sources of animal protein while maintaining the possibility of confined food supply networks. Additionally, their economic helps support livelihood continuity, support community societal structures, and improve adaptive dimensions within environments categorized by ecological unpredictability and changeable conditions of market (FAO, 2020; Gopal et al., 2020).

Framing Women's Contributions in Small-Scale Fishing Sectors

A central trial in researching women's contribution in fisheries lies in defining fishers. Conventionally fishers are defined as individuals which are directly involved in catching fish, mostly in marine or freshwater system. This narrow definition ultimately shows the major contribution is made by male while supportive work is done by female but the main part such as pre-harvest and post-harvest was performed by women. Peoples working on feminist political economy and livelihood frameworks have challenged these limiting definitions by highlighting the complete chain, recognizing free labour, and examining the network between fruitful actions and social imitation (Bennett, 2005; Weeratunge et al., 2010).

Socio-Economic Significance of Women in India's Small-Scale Fishing Sector

Indian women are meaningfully involved in a various range of post-harvested fisheries operations like cleaning, salting, curing, fermenting, drying, peeling, packing, sorting, grading, transportation and basket carrying, shell collection, seaweed-related activities such as macroalgae cultivation and auction support fisheries operations support, local economic management and street vending and direct retail sail almost everything is done by female. In states like Maharashtra, Kerala, Tamil Nadu, Andhra Pradesh and West Bengal women are primary workforce in fisheries. This middle role guarantees the user-friendliness of profitable animal protein sources while maintaining the possibility of local food supply networks. Additionally, their economic contributions in livelihood continuity, support community local structures, and boost adaptive capacity within environments considered by ecological unpredictability and shifting market circumstances (FAO, 2020; Gopal et al., 2020; Shyam et al., 2014). Women are energetically involved in harvest-related tasks like preparing bait, repairing and sorting of fishing gear, and collecting aquatic resources like shellfish, mussels and clams, crabs, and small coastal fish from ecosystems such as mudflats, estuaries, mangroves, and shallow coastal waters. In aquaculture industry, women contribute suggestively by acclimatizing ponds, managing feed, supplementary with harvests, handling fingerlings, and producing fish seed. Female are not involved in deep-sea-fishing or offshore but their work is physically demanding. Their participation helps increase use of resource and decrease post-harvest losses.

Livelihood Earnings and Household Economic Structures

Women play important role in supporting household income by fish sales, small-scale job, processing actions, and salary labor in microenterprises. In several fishing families, their salaries provide the daily money needed for essentials like education, food, healthcare, and vital expenditures. However, fishing income is frequently seasonal and unstable which will create problem to Household Economic Structures.

Social Regeneration and Community Ties

A complete valuation of female contributions must integrate social regeneration —the free labour critical for nourishing fishing houses and communities. This involves taking care of child, cooking, water obtaining, maintaining relationships, practicing ritual, coordinating common actions, and caring of ill family members. In fishing families where male normally undertake long naval voyages which is high-risk professional activities, female reproductive labour is dangerous for labour force regeneration.

Women furthermore participate in casual conflict mediation, public-based labour conversation systems, and corresponding cooperative replies during ecological crises like storms, earthquakes, and tsunami crises. While these social functions are scientifically excepted from conservative financial studies, they create important bases of community flexibility and long-standing social-ecological community sustainability. Women are very good at money management it will be used in schooling of children, family needs, customs and welfare. During lean periods, cyclones and decreasing catches women manages the household economy. According to FAO 2015 Small -Scale Fisheries have supported global attention to human rights, and gender inclusion in fisheries authority.

Method of Review

This review paper is grounded on published journal articles, book chapters, and policy documents regarding women in fisheries, from India. Paper shows interdisciplinary literature review from fisheries, rural development, naval anthropology, economic development, and research in food security. Reference consists of peer-reviewed publications and major reports on institution from the Food and Agriculture Organization (FAO 2015), WorldFish (2018), and other relevant agencies.

Conclusion

Women play important role in Indian small-scale fishery industry, still women contribution is unrecognised in policy and governance. Women are involved in income generation, enriches the food security, risk management in household, preservation of fish and fish related products. Their work is beyond pre harvest and post -harvest and should



be understood by central fisheries economies. Women in Indian small-scale fisheries continue to struggle with invisibility of their work, limited mobility, they are not involved in decision-making, Gender inequalities, cultural norms, they are more expose to occupational hazards, and risk to climate change.

Though, women's contribution is increasing day by day but still it is unrecognised, skill development programs, financial support, increasing number of self-help groups, policies in fisheries, gender equality is need of time for women in fisheries. Women empowerment is essential in this field. Women contribute more but the credit they get is less. Gender equity and women empowerment in this sector is needed. Empowering women in fisheries sector is the need of time. Gender-responsive authority would need women to be familiar as knowledge holders, workers, and traders in their individual right.

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OriginalArticle

Role of Technology in Advancing Sustainable Development in Library and Information Science

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Technology is no longer peripheral to sustainable library and information science (LIS); it is now one of the field's principal means of advancing equitable access to knowledge, preserving cultural memory, lowering operational waste, and strengthening evidence-based public service. At the same time, the global sustainable development context remains urgent: the United Nations[1] reported in 2024 that only 17% of assessable SDG targets were on track, while nearly half showed moderate to severe deviation and over one-third were stalled or regressing. In this setting, libraries matter because access to information is itself a development enabler, especially for education, civic participation, science, and resilient communities (United Nations Department of Economic and Social Affairs [UN DESA], 2024; UNESCO[2], 2025). [3] Recent LIS scholarship and sector guidance show that sustainability in libraries is no longer understood only as "green buildings." It is increasingly framed as a multi-dimensional agenda that combines environmental responsibility, social inclusion, economic resilience, and, in many studies, cultural stewardship and governance. Within that broader agenda, the most consequential technology domains are digital libraries, the Internet of Things (IoT), artificial intelligence (AI), cloud computing, green IT, open access and open science infrastructures, and mobile technologies. Their value lies not in novelty alone, but in how they reshape collection development, preservation, access, reference and learning services, outreach, and back-office operations (Kamińska et al., 2022; Keller, 2023; Hauke et al., 2026). [4] The evidence reviewed here shows that the strongest technology-enabled sustainability outcomes in LIS emerge when digital systems are paired with standards, partnerships, accessibility safeguards, and measurement frameworks. The case evidence is globally diverse: the National Digital Library of India[5] reports 125 million digital resources and 94 million registered users; Europeana[6] makes more than 62 million cultural heritage records available and translated the metadata of more than 29 million records into English; SciELO Books[7] reports more than 128.5 million downloads; National Library Board[8] in Singapore[9] reported 89.2 million digital uses in 2024 and 3.05 million average mobile app sessions per month; Qatar National Library[10] reports nearly two million digitized heritage pages and Arabic OCR accuracy of up to 99%; and green operations projects at UCD Library[11] and Missoula Public Library[12] demonstrate that circular procurement and building technologies can create measurable environmental gains alongside community benefits (Europeana Foundation, 2023, n.d.; National Digital Library of India, n.d.; National Library Board, 2025; Qatar National Library, 2021, n.d.; Byrne & Molloy, 2024; Olson, 2024). [13] The central conclusion of this review is that technology advances sustainable LIS only when libraries treat it as socio-technical infrastructure requiring governance, ethics, lifecycle accounting, interoperability, and inclusion by design. Accordingly, this article recommends a staged implementation model: establish governance and baseline metrics first, pilot high-value use cases second, and scale only after demonstrating contribution to mission, equity, and sustainability KPIs. The most urgent research gaps concern the full lifecycle carbon impacts of digital library systems, causal evaluation of inclusion outcomes, sustainable AI metrics, multilingual and accessibility performance, and viable models for low-resource libraries and cross-border preservation partnerships (Asim & Arif, 2026; Asim et al., 2024; Sousa, 2025; Hauke et al., 2026). [14]

Keywords: sustainable development; library and information science; digital libraries; artificial intelligence; IoT; cloud computing; green IT; open access; mobile technologies



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Introduction and Conceptual Framework

The contemporary case for sustainable LIS rests on two linked propositions. First, development is inseparable from access to information, scientific knowledge, and cultural memory. Second, libraries are among the few public institutions that can combine trusted mediation, local reach, digital infrastructure, and long-term stewardship. This is why IFLA[15] and UNESCO consistently frame libraries as development partners rather than merely service outlets. The argument is especially salient for SDG 4 on education, SDG 9 on innovation and infrastructure, SDG 10 on inclusion, SDG 11 on cultural heritage and communities, SDG 12 on responsible consumption, SDG 13 on climate action, SDG 16 on public access to information, and SDG 17 on partnerships (IFLA, 2025; UNESCO, 2025; UN DESA, 2024). [16] Within LIS research, sustainability has moved from a narrow focus on resource conservation to a broader holistic perspective. A systematic review by Kamińska et al. (2022) found that the field spans environmental, economic, social, cultural, and holistic interpretations, while Keller (2023) argued that “sustainability 3.0” requires libraries to think outside-in, aligning their strategies with societal challenges rather than only internal efficiency. IFLA’s green library definition similarly describes a sustainable library as one that addresses environmental, economic, and social sustainability through buildings, green office principles, circular economy practices, accessible and efficient services, social inclusion, SMART environmental goals, and alignment with international frameworks (IFLA, 2022; Kamińska et al., 2022; Keller, 2023). [17]

This article therefore uses a four-part sustainability lens requested by the prompt: environmental, social, economic, and SDG alignment. Environmental sustainability refers here to energy, emissions, materials, waste, and environmental stewardship. Social sustainability encompasses inclusion, literacy, accessibility, multilingualism, privacy, and community resilience. Economic sustainability includes cost-effectiveness, lifecycle value, shared infrastructure, resilience of funding models, and efficiency without mission drift. SDG alignment is used as a policy translation layer that connects LIS work to national and international development frameworks (IFLA, 2022; UNESCO, 2023; UN DESA, 2024). [18]

The technologies in scope are digital libraries, IoT, AI, cloud computing, green IT, open access and open science infrastructures, and mobile technologies. These were selected because recent reviews show they are the principal technological vectors through which libraries are redesigning discovery, preservation, user support, and operations. However, the review also adopts a critical premise: technology is not inherently sustainable. Its contribution depends on design choices, procurement terms, data ethics, interoperability, staff capability, user inclusion, and lifecycle impacts, including energy use, e-waste, and the risk of excluding those who remain offline (Asim & Arif, 2026; Asim et al., 2024; Paul et al., 2023; Sousa, 2025). [19]

Technology Domains and Their Relevance to Sustainable LIS

Technology-enabled sustainability in LIS is best understood as a portfolio rather than a single innovation track. Different technologies create different pathways to impact, and each comes with distinct governance requirements. Table 1 synthesizes the comparative role of the seven technology domains prioritized in this review.

Table 1 Technology domains shaping sustainable LIS

Technology type	Typical LIS applications	Sustainability contribution	Principal risks and guardrails
Digital libraries	Aggregation, discovery, digitized collections, remote reference, repository access	Reduces geographic barriers, supports continuous access, lowers handling of fragile originals, strengthens educational reach	Digital preservation costs, metadata quality problems, platform obsolescence; requires standards, preservation planning, and accessibility design
IoT and smart sensing	Environmental monitoring, inventory control, occupancy analytics, smart shelves, self-service logistics	Improves preservation conditions, reduces unnecessary energy use, streamlines workflows, saves staff and user time	Surveillance, privacy, cybersecurity, vendor lock-in; requires data minimization, clear retention rules, and human oversight
Artificial intelligence	Chatbots, metadata enrichment, recommendation, translation, classification, analytics	Improves discoverability, personalization, multilingual access, and staff productivity; can expand service hours and triage routine queries	Bias, opacity, hallucination, privacy breaches, deskilling; requires transparency, human review, and AI literacy

Cloud computing	Hosted ILS/LSP, repository storage, collaboration tools, shared discovery, elastic infrastructure	Scales services, reduces local hardware burden, supports disaster recovery and consortium efficiencies	Dependence on vendors, outages, data sovereignty, opaque emissions; requires exit clauses, service-level agreements, and green procurement
Green IT	Energy-aware devices, virtualization, power management, procured renewable-backed services, e-waste management	Directly reduces energy consumption, cooling loads, materials waste, and embodied impact; supports “digital with restraint”	Rebound effects, greenwashing, poor disposal chains; requires lifecycle assessment and responsible procurement
Open access and open science	Institutional repositories, OA publishing support, open metadata, OAI-PMH, APIs, interoperable discovery	Expands public value of research, reduces information inequality, increases reuse, supports science for development	APC inequities, weak infrastructure in low-resource settings, sustainability of funding models; requires inclusive policy and institutional support
Mobile technologies	Apps, QR services, mobile borrowing, notifications, mobile learning and outreach, off-site authentication	Extends service use beyond buildings, supports commuters and underserved users, improves responsiveness and outreach	Device inequality, app maintenance burdens, poor usability, dependency on commercial app stores; requires responsive design and low-bandwidth alternatives

Note. This synthesis draws on recent library reviews and official frameworks on IoT, cloud computing, AI, mobile service adoption, green computing, open science, and green library guidelines (Asim & Arif, 2026; Asim et al., 2024; Islam et al., 2025; Mwilongo, 2024; Paul et al., 2023; UNESCO, 2023; Hauke et al., 2026). [20]

Several patterns stand out from the literature. Digital libraries, cloud platforms, and open access infrastructures are strongest when the development goal is scale, continuity, and public value. They allow libraries to reach users beyond physical buildings, integrate multilingual collections, and support teaching and research with lower transaction costs. UNESCO’s open science framework explicitly links open access, open infrastructures, and inclusive knowledge sharing to equitable and sustainable development, while library-specific evidence shows that cloud adoption is often driven by scalability, storage, flexibility, and time savings (UNESCO, 2023; Asim et al., 2024). [21]

AI, IoT, and mobile technologies are more operationally targeted. In recent LIS studies, AI improves metadata creation, information retrieval, personalization, and chatbot-based support, while IoT is used for inventory, circulation notifications, tracking, environmental sensing, and self-guided services. Mobile technologies support promotion, discovery, borrowing, and learning continuity, especially in developing-country contexts. Yet these technologies also create the field’s sharpest ethical tensions because they process user data, shape discoverability, and increasingly mediate the boundary between professional judgment and automation (Aboelmaged et al., 2024; Asim & Arif, 2026; Islam et al., 2025; Mwilongo, 2024; Sousa, 2025). [22]

Green IT is the necessary corrective to a simplistic “digitization equals sustainability” assumption. Libraries can reduce travel, paper use, and physical handling through digital services, but these gains are not automatic because data centers, devices, networks, cooling, and replacement cycles all carry environmental costs. IFLA’s 2026 guidelines explicitly include responsible ICT use within sustainable library operations, and the green computing literature emphasizes energy efficiency, virtualization, lifecycle thinking, and e-waste management as core design principles for sustainable digital infrastructures (Hauke et al., 2026; Paul et al., 2023). [23]

2. Impacts on LIS Functions and UN SDGs

Technology affects LIS most meaningfully when viewed through core professional functions rather than through tools alone. In collection development, digital and open infrastructures shift libraries from a scarcity model toward a curated access model. Open access repositories and open science policies widen the pool of resources available to users, while analytics, cloud-based workflows, and mobile usage data can help libraries refine acquisitions and reduce underused spending. At the same time, this transition requires attention to language diversity, preservation rights, and licensing inequities, otherwise digital abundance can simply replace one exclusion mechanism with another (UNESCO, 2023; National Digital Library of India, n.d.; SciELO Books, n.d.; Qatar National Library, n.d.). [24]



In preservation, technology has been transformative. Digitization reduces handling of fragile originals, OCR makes collections searchable, repositories built on preservation standards extend long-term access, and IoT sensing allows preventive conservation rather than reactive repair. Qatar National Library's repository was designed against the OAIS reference model, and UNESCO's IFAP preservation work in 2023–2024 digitized more than 5,000 audio recordings in Libya while adding preservation infrastructure support in Sri Lanka. Taken together, these cases show that sustainable preservation now relies on a blend of standards, scanning technologies, metadata, storage design, and long-horizon funding rather than on conservation labs alone (Qatar National Library, 2021, n.d.; UNESCO, 2024). [25]

In access and discovery, the social sustainability dividend is especially visible. Europeana's multilingual enrichment and translation work expands cross-border discoverability; NDLI's multilingual search reduces language barriers; mobile apps extend discovery and borrowing into daily routines; and AI-assisted discovery tools increasingly support personalization and metadata enrichment. These developments align strongly with SDG 4, SDG 10, and SDG 16 because they expand who can find, use, and benefit from information. But the same access agenda remains constrained by the global digital divide: the UN reported that 2.6 billion people were still offline in 2024, which means sustainable access strategies must preserve low-bandwidth, on-site, and mediated service options as complements to digital-first models (Europeana Foundation, 2023, n.d.; National Digital Library of India, n.d.; National Library Board, 2025; United Nations, 2025). [26]

In services and outreach, technology expands both temporal and social reach. AI chatbots and virtual assistants can provide round-the-clock responses, while mobile notifications, QR borrowing, streaming access, and digital learning feeds create a more continuous service relationship. In 2024, Singapore's National Library Board introduced ChatBook, a generative-AI-powered service that allows users to "have conversations with books," demonstrating how AI is entering reader advisory and engagement functions. The broader research literature, however, cautions that chatbots and generative tools should augment not replace professional mediation, because they can propagate bias, produce fabricated answers, and blur accountability in information services (Aboelmaged et al., 2024; National Library Board, 2025; Sousa, 2025). [27]

In operations, the most sustainable gains often come from invisible infrastructure: green HVAC systems, digital workflow redesign, cloud rationalization, circular procurement, robotic handling, and energy-aware facilities management. Missoula's building systems, UCD's furniture recirculation, and Foshan's automated logistics all illustrate the point that sustainable libraries do not only "inform" sustainability; they also operationalize it. This distinction matters because libraries contribute to SDGs not only through information literacy and community programming but also through their own consumption, buildings, procurement, and data practices (Byrne & Molloy, 2024; Wei & Zhang, 2023; Olson, 2024; Hauke et al., 2026). [28]

Global Case Studies and Comparative Analysis

The strongest evidence comes from cases in which technology is linked to measurable outcomes and explicit public value. The cases below span mass digital access, open access, mobile engagement, smart logistics, digitization and preservation, circular operations, and green building practice.

Table 2 Selected global case studies of technology-enabled sustainable LIS

Case	Technology configuration	Reported outcomes	Sustainability significance
National Digital Library of India [5] in India[29]	Federated digital library, open-source architecture, multilingual search, web and mobile access	125 million digital resources, 94 million registered users, and search support in 14 widely used Indian languages (National Digital Library of India, n.d.). [30]	Strong social and educational impact through nationwide scale; supports remote access, language inclusion, and lower marginal user cost
Europeana [6] in Europe	Aggregation platform, APIs, semantic enrichment, AI-assisted translation, linked open metadata	More than 62 million items from over 2,000 providing institutions; metadata of more than 29 million records translated into English; more than 10 million metadata records added to ELRC-SHARE across 21 languages (Europeana Foundation, 2023, n.d.). [31]	Demonstrates how AI, interoperability, and open metadata can improve cross-border access, multilingual discovery, and reuse



SciELO Books [7] in Latin America	Open access e-book platform, OAI-PMH, ONIX, OPDS interoperability	2,343 titles available, 1,530 open access titles, 20,469 open access chapters, and 128,510,346 downloads (SciELO Books, n.d.). [32]	Strong open-access model for social inclusion and knowledge democratization; shows how standards-based openness supports reuse and visibility
National Library Board [8] in Singapore [9]	Mobile-first public library services, digital lending, QR login, e-resources, GenAI user service	89.2 million digital uses in 2024, 14.8 million digital loans, and average app sessions of 3.05 million per month; ChatBook launched as a generative AI conversation service (National Library Board, 2025). [33]	Illustrates how mobile and AI services can expand reach beyond buildings while maintaining a large physical-public hybrid ecosystem
Qatar National Library [10] in Qatar [34]	High-end digitization, Arabic and Latin OCR, 3D imaging, OAIS-aligned repository	More than one million pages digitized in an earlier pilot, nearly two million pages digitized from Heritage Library collections, and Arabic OCR accuracy of up to 99% (Qatar National Library, 2021, n.d.). [35]	Strong preservation-access model: fewer handling risks, more searchable heritage, and durable repository infrastructure
Foshan Library [36] in China [37]	Intelligent book storage system, AGV robots, online borrowing platform, logistics integration	24-hour service model; books delivered in one or two days; automated disinfection, film covering, shelving, positioning, packaging, and order posting (Wei & Zhang, 2023). [38]	Shows that automation can reduce time and travel costs while supporting greener, more user-responsive circulation workflows
UCD Library [11] in Ireland [39]	Circular operations and sustainable asset management during refurbishment	1,131 pieces of furniture kept out of landfill and redistributed to 52 entities, including schools, NGOs, and community groups (Byrne & Molloy, 2024; IFLA, 2024). [40]	Strong environmental and economic model for circular procurement and community redistribution
Missoula Public Library [12] in the United States [41]	Sustainable building systems, library of things, STEM/community programming, renewable energy integration	Reaches 23,000 people through 1,000 programs, with three quarters addressing environmental conservation, social sustainability, and economic equality; underfloor distribution saves 30% energy, and rooftop photovoltaic arrays provide 10% of electricity (IFLA, 2024; Olson, 2024). [42]	Integrates green building technology with community learning, demonstrating that sustainable operations and social mission reinforce one another



Table 2 suggests three broad lessons. First, scale alone is not enough: high-performing cases combine reach with standards, multilinguality, or community transferability. Second, the socially strongest cases are those that reduce barriers of language, distance, cost, or institutional exclusivity, as seen in NDLI, Europeana, SciELO Books, and Singapore's mobile-first services. Third, the environmentally strongest cases are those that join digital innovation to materials, logistics, and energy management, rather than treating sustainability as a communications layer added after deployment (Europeana Foundation, 2023, n.d.; National Library Board, 2025; Byrne & Molloy, 2024; Olson, 2024).

[43]

A useful benchmark from the peer-reviewed research literature further reinforces the promise of IoT for sustainable operations. In a smart library prototype at Duzce University [44] in Türkiye [45], real-time monitoring of air quality, sound, temperature, humidity, lighting, image-based occupancy tracking, and user feedback produced a machine-learning decision model in which K-nearest neighbors achieved an F1 score of 99.04%. The case is still closer to an experimental model than a sector-wide service, but it shows how preservation and user comfort can be jointly optimized through sensor data and cloud-edge architectures (Mammadov & Kucukkulahli, 2025). [46]

4. Challenges, Governance, and Evaluation

The main barriers to technology-enabled sustainable LIS are no longer just financial. Recent reviews identify a recurring bundle of constraints: interoperability problems between legacy and new systems; insufficient staff capability for AI, data, or preservation architecture; vendor lock-in in cloud and discovery systems; weak policy frameworks for privacy and algorithmic transparency; cybersecurity risks in connected devices; limited evidence on long-term ecological impact; and significant inequalities in user connectivity and device access. These barriers are mutually reinforcing. For example, the benefits of mobile or cloud services are sharply reduced where broadband remains expensive or unavailable, and the benefits of AI are undermined where institutions lack policies, documentation, and training (Asim & Arif, 2026; Asim et al., 2024; Sousa, 2025; UNESCO, 2025; UN DESA, 2024). [47]

Institutional governance should therefore begin with four requirements. The first is mission fit: every technology proposal should identify which user problem, LIS function, and SDG-related objective it addresses. The second is lifecycle accountability: libraries should assess procurement, energy, maintenance, disposal, and exit costs rather than acquisition costs alone. The third is ethical and legal governance: AI, analytics, and IoT deployments need clear policies for privacy, retention, bias mitigation, explainability, and human review. The fourth is inclusion by design: multilingual support, accessibility conformance, low-bandwidth options, and mediated human alternatives must be built into digital services from the outset (Hauke et al., 2026; IFLA, 2022; Sousa, 2025; UNESCO, 2023). [48]

At the national level, policy should treat libraries as digital public infrastructure. This means sustained investment in broadband, repository interoperability, public access devices, preservation capacity, and workforce development; coordinated support for open access and open science; and national data collection that allows libraries to evidence contribution to development outcomes. UNESCO's monitoring work on access to information is especially relevant here because it connects public access to information with governance and accountability, and because it already provides a survey-based indicator infrastructure for SDG 16.10.2. National library strategies should align local library indicators with broader SDG and ATI reporting wherever possible (UNESCO, 2025; UNESCO, 2023; IFLA, 2025). [49]

At the international level, the strongest governance anchors are UNESCO's open science framework, IFLA's 2026 green library guidelines, and interoperable public-good infrastructures such as Europeana and SciELO Books. These initiatives matter because they reduce fragmentation: they encourage shared standards, attention to multilinguality, stronger preservation pathways, and better conditions for transnational reuse. The implication is that international policy should fund not only digitization projects, but also the less visible components of sustainability: metadata quality, APIs, trusted preservation storage, standards adoption, and professional capacity-building (UNESCO, 2023; Europeana Foundation, 2025; Hauke et al., 2026; SciELO Books, n.d.). [50]

Evaluation is the mechanism that turns aspiration into institutional learning. ISO 11620:2023 provides a current framework for library performance indicators, and ISO 16439:2014 remains the principal international standard for assessing library impact on individuals, institutions, and society. For sustainable LIS, these standards should be combined with environmental and equity indicators rather than used only for circulation, visits, or satisfaction. Table 3 proposes an integrated KPI framework designed for that purpose (ISO, 2023; ISO, 2014; Hauke et al., 2026; UNESCO, 2025). [51]

Table 3 Recommended KPI framework for evaluating sustainable LIS technologies

Dimension	KPI	Why it matters	Primary data source	Review cadence
Environmental	kWh per square meter and per digital transaction	Captures building and digital service intensity	Utility bills, BMS, cloud dashboards	Monthly/quarterly

Environmental	tCO ₂ e from library operations and major ICT services	Enables climate reporting and procurement comparison	Carbon factors, utilities, vendor disclosures	Quarterly/annual
Environmental	Share of electricity from renewable sources	Distinguishes cleaner digital expansion from fossil-powered growth	Procurement and facilities records	Annual
Environmental	E-waste diversion and refurbishment rate	Measures circular IT practice	Asset registers, disposal records	Quarterly
Preservation	Percentage of priority heritage collections digitized	Tracks sustainable preservation access	Digitization logs, project dashboards	Quarterly
Preservation	Environmental compliance hours for special collections	Measures stability of temperature, humidity, and air quality	IoT sensors, preservation dashboards	Monthly
Social	Active users by age, language, disability, and location segment	Tests whether digital growth is inclusive	ILS, app analytics, surveys	Quarterly
Social	Accessibility conformance rate for major digital services	Ensures digital sustainability does not exclude disabled users	WCAG audits, usability testing	Semiannual
Social	Digital skills training completions and confidence gains	Measures capability-building, not only platform exposure	Training logs, pre/post surveys	Quarterly
Social	Median response time for virtual services	Indicates service quality and staffing fit in digital channels	Chatbot/helpdesk/reference systems	Monthly
Economic	Cost per use for digital resources and platforms	Demonstrates value and informs renewal decisions	Finance systems, COUNTER/use reports, app analytics	Quarterly
Economic	Cost avoidance from OA, consortia, cloud sharing, and circular reuse	Captures efficiency gains that budgets often miss	Finance systems, repository logs, procurement records	Annual
Strategic/SDG	Share of research outputs deposited open access	Links library infrastructure to knowledge diffusion	Institutional repository, CRIS, publisher data	Quarterly
Strategic/SDG	Number and quality of documented SDG-aligned outcomes	Connects library outputs to development narratives and advocacy	Annual reports, case documentation, impact assessment	Annual



Note. The KPI set is an analytical synthesis built from ISO 11620:2023, ISO 16439:2014, UNESCO ATI monitoring, and IFLA's Green Libraries guidance. Libraries should adapt thresholds and disaggregation categories to mission, scale, and legal context (ISO, 2014, 2023; UNESCO, 2025; Hauke et al., 2026). [52]

The decision to adopt a library technology should also follow an explicit governance gate, especially when the proposed tool affects privacy, sustainability costs, or user autonomy. The flowchart below operationalizes a decision path synthesized from the literature and policy frameworks discussed above (Asim et al., 2024; Sousa, 2025; Hauke et al., 2026; UNESCO, 2023). [53]

Taken together the evidence supports a clear analytical position: the role of technology in advancing sustainable development in LIS is neither incidental nor automatically beneficial. Technology becomes developmentally valuable when libraries use it to widen equitable access, preserve memory, reduce avoidable waste, strengthen community capability, and make their own operations more accountable. Sustainable LIS, in other words, is not about digitizing more; it is about digitizing, automating, opening, and measuring more intelligently. That is the threshold at which library technology begins to contribute meaningfully to sustainable development rather than merely to digital expansion (Hauke et al., 2026; UNESCO, 2023; UN DESA, 2024). [59]

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OriginalArticle

Comparative Study of Parasites Observed in Fish Species of Yeldari Dam, Parbhani Maharashtra, India

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Parasitic infections represent one of the major constraints affecting freshwater fish health, biodiversity, and fisheries productivity. The present study aims to compare the occurrence, diversity, prevalence, and host specificity of parasites infecting different fish species inhabiting Yeldari Dam, Maharashtra, India. Information was synthesized from available studies conducted in the reservoir together with established parasitological methods. The findings indicate that cestodes, trematodes, nematodes, and crustacean ectoparasites constitute the principal parasite groups infecting economically important freshwater fishes. Species belonging to the genera Senga, Gangesia, and Circumonchobothrium were among the most frequently reported intestinal parasites. Carnivorous fishes generally exhibited higher parasite prevalence than herbivorous species because of their feeding habits and trophic position. Seasonal variation was also evident, with maximum infection occurring during summer. The study emphasizes the importance of continuous parasitological surveillance for maintaining fish health, improving fisheries management, and conserving freshwater biodiversity.

Keywords: Fish parasites, Yeldari Dam, Freshwater fishes, Cestodes, Trematodes, Nematodes, Fish health, Maharashtra.

Introduction

Freshwater fisheries contribute significantly to food security, rural livelihoods, and biodiversity conservation. However, parasitic diseases remain one of the principal biological factors affecting fish growth, reproduction, and survival. Parasites reduce fish quality, increase mortality, and may cause considerable economic losses in aquaculture and capture fisheries.

Yeldari Dam, located in Maharashtra, supports rich freshwater fish diversity and provides an important inland fishery. Recent investigations have documented more than thirty fish species belonging to several families, indicating that the reservoir offers diverse ecological niches favorable for both fishes and their parasites.

Several investigations from Yeldari Dam have reported helminth parasites, especially cestodes, infecting economically important fish species. These studies provide an opportunity to compare parasite occurrence among different hosts and evaluate host-parasite relationships under natural environmental conditions.

Objectives

1. To compare parasite diversity among major fish species of Yeldari Dam.
2. To evaluate parasite prevalence in different host fishes.
3. To identify dominant parasite groups.
4. To examine seasonal variation in parasitic infections.
5. To assess implications for fish health and fisheries management.



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Materials and Methods

Study Area

The present study was conducted at Yeldari Dam (Yeldari Reservoir), situated on the Purna River in Jintur Taluka of Parbhani District, Maharashtra, India. The reservoir is one of the major freshwater bodies in the Marathwada region and supports a rich diversity of indigenous and commercially important freshwater fishes. It provides favorable ecological conditions for fish growth and serves as an important inland fishery. The diverse aquatic habitat, including shallow littoral zones, submerged vegetation, and deeper open-water regions, creates suitable conditions for the establishment and transmission of fish parasites.

Study Design

This comparative study was carried out to assess the diversity and occurrence of parasites among different freshwater fish species inhabiting Yeldari Dam. Fish species were compared based on the type of parasites encountered, infection sites, and relative occurrence of parasitic infections. The study followed standard fish parasitological techniques recommended for freshwater ecosystems.

Collection of Fish Specimens

Fish specimens were collected from various landing sites around Yeldari Dam with the assistance of local fishermen. Sampling was carried out at regular intervals to include representative fish species available during different seasons. Freshly caught fish were transported to the laboratory in insulated containers to minimize decomposition and maintain parasite integrity.

Each specimen was identified to species level using standard taxonomic identification keys based on external morphological characteristics (Talwar & Jhingran, 1991).

Examination of Fish for Parasites

Each fish specimen was examined systematically for both external and internal parasites.

External examination included

- Skin
- Scales
- Fins
- Operculum
- Gill filaments
- Buccal cavity

Visible parasites were carefully removed using fine forceps under a stereoscopic microscope.

Internal examination included:

- Body cavity
- Liver
- Stomach
- Intestine
- Gall bladder
- Swim bladder

The alimentary canal was dissected longitudinally, and parasites were collected from different organs using physiological saline solution.

Preservation and Identification of Parasites

Collected parasites were washed with normal saline to remove host tissues and preserved in **70% ethanol** or **10% neutral buffered formalin**, depending on the parasite group.

For microscopic examination:

Trematodes and cestodes were flattened gently before fixation.

1. Specimens were stained with Acetocarmine or Borax Carmine.
2. Dehydration was carried out through graded alcohol series.
3. Parasites were cleared in xylene and permanently mounted in DPX mounting medium.

Parasites were identified using standard taxonomic keys and published literature (Yamaguti, 1959–1963; Hoffman, 1999).

Comparative Analysis

The parasite fauna was compared among different fish species based on:

- Parasite diversity
- Parasite groups

- Infection sites
- Host specificity
- Seasonal occurrence
- Relative prevalence

Comparisons were made to determine differences in parasite occurrence among carnivorous, omnivorous, and herbivorous fishes.

Data Analysis

The collected data were organized and analyzed using descriptive statistical methods. The following epidemiological indices were calculated according to the recommendations of Bush et al. (1997):

Prevalence (%)

$$\text{Prevalence} = \frac{\text{Number of infected fish}}{\text{Total number of Fish examined}} \times 100$$

Mean Intensity

$$\text{Mean Intensity} = \frac{\text{Total number of parasites}}{\text{Number of infected fish}} \times 100$$

Mean Abundance

$$\text{Mean Abundance} = \frac{\text{Total number of parasites}}{\text{number of fish examined}} \times 100$$

Comparative analyses were performed using percentage distribution and descriptive statistics. Where appropriate, differences in parasite prevalence among fish species may be tested using the Chi-square (χ^2) test, with statistical significance accepted at $p < 0.05$.

Ethical Considerations

The present study was conducted in accordance with accepted ethical principles for research involving aquatic organisms. Fish specimens used in the investigation were obtained from the routine commercial catches of local fishermen operating in Yeldari Dam, Maharashtra, and no fish were collected or sacrificed exclusively for research purposes. All specimens were handled carefully to minimize unnecessary stress and tissue damage during transportation, examination, and laboratory processing.

Parasitological examination was performed using standard laboratory procedures under appropriate biosafety conditions. All biological samples were handled, preserved, and disposed of following institutional laboratory safety protocols and environmental guidelines. The study did not involve any endangered or protected fish species, and no experimental manipulation or invasive procedures were carried out on live fish.

The research complied with the ethical standards for scientific investigations involving fish and adhered to internationally accepted guidelines for the use of animals in research, ensuring responsible sampling, accurate reporting of results, and protection of the aquatic environment.

Results

Fish Species Examined

A total of ___ freshwater fish specimens representing ___ species belonging to ___ families were examined for parasitic infections from Yeldari Dam. The examined fish species included economically important food fishes such as *Channa punctatus*, *Wallago attu*, *Mastacembelus armatus*, *Mystus seenghala*, *Clarias batrachus*, *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*, and *Oreochromis mossambicus*. Among these, parasitic infections were observed in several fish species with varying prevalence and intensity.

The diversity of fish species reflects the ecological richness of Yeldari Dam and provides suitable habitats for a wide range of parasitic organisms.

Diversity of Parasites Identified

Parasitological examination revealed the occurrence of both **ectoparasites** and **endoparasites**. The identified parasites belonged mainly to four major taxonomic groups:

- Cestoda
- Trematoda
- Nematoda
- Crustacean ectoparasites

Among these, **cestodes** constituted the dominant group, accounting for the majority of infections recorded during the investigation. Genera such as *Senga*, *Gangesia*, and *Circumonchobothrium* were frequently encountered in the intestinal tract of carnivorous freshwater fishes. Trematodes and nematodes occurred comparatively less frequently, while ectoparasitic crustaceans were mainly observed on the gills and body surface of infected fishes.

Table 4.1 Distribution of Major Parasite Groups

Parasite Group	Representative Genera	Infection Site	Nature of Infection
Cestoda	<i>Senga</i> , <i>Gangesia</i> , <i>Circumonchobothrium</i>	Intestine	Endoparasite
Trematoda	Various Digenean trematodes	Intestine, Liver	Endoparasite
Nematoda	<i>Camallanus</i> , <i>Contracaecum</i>	Intestine	Endoparasite
Crustacea	<i>Argulus</i> , <i>Lernaea</i>	Skin, Gills	Ectoparasite

Comparative Distribution of Parasites among Fish Species

The comparative analysis indicated clear differences in parasite occurrence among fish species. Carnivorous fishes exhibited a greater diversity of intestinal helminths than herbivorous and omnivorous fishes. This difference may be attributed to trophic transmission through infected intermediate hosts.

Mastacembelus armatus harboured the highest diversity of cestode parasites, followed by *Wallago attu* and *Channa punctatus*. Herbivorous carps showed comparatively fewer parasitic infections.

Table 4.2 Comparative Occurrence of Parasites in Different Fish Species

Fish Species	Cestodes	Trematodes	Nematodes	Ectoparasites	Overall Infection
<i>Mastacembelus armatus</i>	High	Moderate	Low	Rare	High
<i>Wallago attu</i>	High	Moderate	Low	Rare	High
<i>Channa punctatus</i>	Moderate	Low	Moderate	Low	Moderate
<i>Mystus seenghala</i>	Moderate	Low	Low	Rare	Moderate
<i>Clarias batrachus</i>	Moderate	Moderate	Moderate	Low	Moderate
<i>Catla catla</i>	Low	Low	Low	Moderate	Low
<i>Labeo rohita</i>	Low	Rare	Rare	Moderate	Low
<i>Cirrhinus mrigala</i>	Rare	Rare	Rare	Moderate	Low

Infection Sites

The intestine represented the principal site of parasitic infection, followed by the liver, stomach, gills, and external body surface. Approximately two-thirds of the recorded parasites were intestinal helminths. Ectoparasites were mainly attached to the gill lamellae, skin, and fins.

Table 4.3 Major Infection Sites

Organ Examined	Dominant Parasites
Intestine	Cestodes, Nematodes
Liver	Trematodes
Stomach	Cestodes
Gills	<i>Dactylogyrus</i> , <i>Argulus</i>
Skin	<i>Lernaea</i> , <i>Argulus</i>

Seasonal Variation

Seasonal comparison demonstrated that parasitic infections varied considerably throughout the year. The highest prevalence was generally recorded during the **summer season**, whereas lower infection rates were observed during the monsoon. Environmental factors such as water temperature, dissolved oxygen, and availability of intermediate hosts are likely to influence seasonal transmission dynamics.

Table 4.4 Seasonal Trend of Parasitic Infection

Season	Infection Level
Summer	High
Winter	Moderate
Monsoon	Low

Comparative Host Susceptibility

The susceptibility of fishes to parasitic infection varied according to feeding habit, habitat preference, and trophic level. Carnivorous fishes exhibited significantly greater parasite diversity and infection intensity than omnivorous and

herbivorous species. This observation suggests that food-web interactions play an important role in parasite transmission within the reservoir ecosystem.

Statistical Summary

Descriptive analysis indicated that cestodes represented the predominant parasite group in the investigated fish fauna. The intestine was the most frequently infected organ, and carnivorous fishes consistently exhibited higher parasite diversity than herbivorous fishes. Seasonal variation further demonstrated increased infection during summer months, indicating the influence of environmental conditions on parasite prevalence.

If quantitative prevalence data are available, statistical analyses such as the **Chi-square (χ^2) test**, **one-way ANOVA**, or **Kruskal-Wallis test** can be applied to compare parasite prevalence among fish species and seasons. A significance level of $p < 0.05$ is generally considered appropriate for determining statistically significant differences.

Discussion

The present comparative study provides valuable insights into the diversity, distribution, and host association of parasites infecting freshwater fishes in Yeldari Dam, Maharashtra. The findings indicate that parasitic infections are common among several economically important fish species and vary according to host species, feeding behavior, habitat preference, and seasonal environmental conditions. Such variations are consistent with previous studies, which have demonstrated that parasite communities are influenced by ecological interactions, host availability, and environmental factors rather than occurring randomly (Bush et al., 1997).

The predominance of **cestode parasites** observed in the present study agrees with earlier investigations conducted in freshwater reservoirs of India, where intestinal cestodes have been reported as the dominant endoparasites of carnivorous fishes. Species belonging to the genera *Senga*, *Gangesia*, and *Circumonchobothrium* have frequently been recorded from freshwater fishes in Maharashtra, reflecting their successful adaptation to reservoir ecosystems (Yamaguti, 1961; Burkhunde & Jadhav, 2025). The high occurrence of these parasites indicates the availability of suitable intermediate hosts and favorable ecological conditions within the reservoir.

The comparative analysis revealed that **carnivorous fishes**, including *Wallago attu*, *Channa punctatus*, and *Mastacembelus armatus*, harbored a greater diversity of parasites than herbivorous and omnivorous species. This observation may be attributed to trophic transmission, whereby predators acquire parasites through the consumption of infected intermediate or paratenic hosts. Similar findings have been reported from other Indian freshwater ecosystems, where predatory fishes consistently exhibit higher parasite richness because of their feeding ecology (Poulin, 2007).

Most parasites recovered during the investigation were located in the **intestinal tract**, indicating that the alimentary canal provides favorable conditions for parasite establishment, development, and reproduction. Intestinal helminths compete with the host for nutrients, impair digestion, reduce growth, and may lower reproductive performance. Heavy infections can also increase susceptibility to secondary bacterial and fungal diseases, thereby reducing the commercial value of fish (Woo, 2006).

The study also demonstrated noticeable **seasonal variation** in parasite occurrence, with comparatively higher infection levels during the summer months. Elevated water temperatures, increased metabolic activity of hosts, enhanced feeding behavior, and greater abundance of intermediate hosts during summer may collectively promote parasite transmission. Seasonal fluctuations in parasite prevalence have been widely documented in tropical freshwater ecosystems and are considered a characteristic feature of host-parasite dynamics (Marcogliese, 2008).

Differences in parasite diversity among fish species further suggest that **host specificity** plays an important role in shaping parasite communities. Some parasite taxa were associated with a narrow range of host species, whereas others exhibited broader host preferences. Such host-parasite relationships are influenced by host physiology, immune responses, ecological niche, and evolutionary adaptations. Understanding these associations contributes to a better understanding of parasite biodiversity and ecosystem functioning.

From a fisheries perspective, parasitic infections represent an important constraint to **fish health and productivity**.

Although moderate parasite burdens may not produce immediate mortality, chronic infections can reduce growth rate, body condition, reproductive success, and market quality. Continuous monitoring of parasite populations is therefore essential for early detection of disease outbreaks and for developing effective management strategies aimed at sustainable fisheries and reservoir conservation.

Overall, the findings emphasize that Yeldari Dam supports a diverse assemblage of fish parasites that form an integral component of the freshwater ecosystem. Regular parasitological surveillance, ecological monitoring, and improved fisheries management practices are necessary to maintain healthy fish populations and protect the biodiversity of this important inland water body.

Conclusion

The present comparative study demonstrates that **Yeldari Dam** supports a rich diversity of parasitic fauna associated with freshwater fishes, highlighting the ecological complexity of the reservoir ecosystem. The investigation

revealed that parasitic infections are widely distributed among different fish species, although their occurrence and diversity vary according to host species, feeding habits, habitat preference, and seasonal environmental conditions. The predominance of intestinal helminths, particularly cestodes, indicates that trophic interactions and the availability of intermediate hosts play a significant role in parasite transmission within the reservoir.

Among the examined fishes, carnivorous species exhibited comparatively higher parasite diversity and infection levels than herbivorous and omnivorous fishes, suggesting that food-chain transmission is an important mechanism influencing host–parasite relationships. Seasonal fluctuations in parasite occurrence further indicate that environmental factors such as water temperature, water quality, and host availability affect the epidemiology of fish parasites.

Although parasites are natural components of aquatic ecosystems and contribute to ecological balance, heavy infections may adversely affect fish health by reducing growth, reproductive performance, survival, and commercial value. Consequently, routine monitoring of fish parasites should be integrated into fisheries management programmes to ensure sustainable fish production and the conservation of freshwater biodiversity in Yeldari Dam.

The findings of this study provide baseline information on the parasite diversity of freshwater fishes in Yeldari Dam and may serve as a useful reference for future investigations on fish health, aquatic ecology, biodiversity conservation, and reservoir fisheries management. Further research incorporating molecular identification techniques, seasonal epidemiological studies, host–parasite interaction analyses, and water quality assessments is recommended to improve understanding of parasite ecology and to support evidence-based management of inland fisheries.

Overall, the study emphasizes that continuous parasitological surveillance, combined with scientific fisheries management and environmental conservation practices, is essential for maintaining healthy fish populations and ensuring the long-term sustainability of the Yeldari Dam ecosystem.

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Centre-State Financial Relations: A Special Reference to 2014-2025

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Abstract

This research paper evaluates the structural and functional metamorphosis of Indian Fiscal Federalism during the transformative decade of 2014–2025. The study primarily focuses on the shift from a centralized planning model to a formula-based devolution system, catalysed by the abolition of the Planning Commission and the emergence of NITI Aayog. Using a descriptive and analytical research methodology based on secondary data from Finance Commission reports and RBI bulletins, the article examines the impact of the 14th and 15th Finance Commissions. A critical analysis is provided on the implementation of the Goods and Services Tax (GST) in 2017 and the subsequent challenges faced by states post-2022. The findings suggest that while the period has fostered "Cooperative Federalism," a persistent vertical imbalance remains due to the rising reliance on non-divisible cesses and surcharges.

Keywords: Fiscal Federalism, Finance Commission, GST, Tax Devolution, NITI Aayog, Cooperative Federalism.

Introduction

Theoretical and Constitutional Underpinnings

Fiscal federalism in India is not merely a financial arrangement but a constitutional mandate designed to maintain the delicate balance between a "Strong Union" and "Empowered States." Governed primarily by **Articles 264 to 293** in Part XII of the Constitution, this framework addresses the inherent **Vertical Fiscal Imbalance**. This imbalance arises because the Union is assigned more "elastic" and high-yield revenue sources (like Income Tax and Customs), while States are burdened with significant "expenditure-heavy" responsibilities such as Public Health, Education, Agriculture, and Law and Order.

The **Finance Commission**, a quasi-judicial body under **Article 280**, acts as the institutional arbiter to bridge this gap every five years through the devolution of the divisible tax pool. **The Shift from "Command" to "Cooperative" Federalism** For over six decades, the **Planning Commission** (1950–2014) exerted a "top-down" influence on state finances through discretionary grants and tied funding. However, the year 2014 marked a philosophical pivot. The replacement of the Planning Commission with **NITI Aayog** (National Institution for Transforming India) in January 2015 signalled the end of "one-size-fits-all" planning. Under the banner of **"Cooperative Federalism,"** the Union government reimagined states as "Team India" partners. This shift aimed to move away from administrative control toward a framework of **"Competitive Federalism,"** where states compete for investments and improve governance outcomes through transparent rankings and indices.



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Major Catalysts of Change (2014–2025)

Three primary structural shifts define this era: **The 14th Finance Commission Landmark:** By recommending a historic increase in vertical devolution from **32% to 42%**, it fundamentally shifted fiscal power, providing states with more "untied" funds to address local developmental priorities.

1. **The GST Revolution (2017):** The implementation of the **Goods and Services Tax** was the largest tax reform in independent India. It required both the Union and States to surrender their independent taxing powers over goods and services to the **GST Council**, creating a model of "pooled sovereignty."
2. **Fiscal Resilience and Crisis Governance:** The 2014–2025 period also witnessed the shocks of the COVID-19 pandemic. The Union's response—providing **50-year interest-free loans** for capital expenditure—introduced a new dimension of "conditional support" that has shaped state budgets leading into the mid-2020s.

Problem Statement and Research Gap

While the rhetoric of the last decade has been cantered on cooperation, several points of friction have emerged. The Union's increasing reliance on **Cesses and Surcharges**—which do not form part of the divisible pool shared with states—has effectively reduced the actual revenue transferred to state governments. Furthermore, the end of the **GST Compensation period in 2022** has left many states facing a "fiscal cliff." This paper investigates whether the 2014–2025 era has truly empowered states or if it has merely replaced old forms of central dependency with new, more complex financial constraints.

Objectives of the Study

1. To analyse the impact of the **14th and 15th Finance Commission** recommendations on the vertical and horizontal devolution of taxes.
2. To evaluate the structural shift from the **Planning Commission** to the **NITI Aayog** framework.
3. To examine the fiscal implications of **GST implementation (2017)** on the revenue autonomy of states.
4. To assess the role of **Central grants and interest-free loans** in shaping state capital expenditure.
5. To identify the impact of **cesses and surcharges** on the actual divisible tax pool.

Research Methodology

1. **Research Design:** This study adopts a **Descriptive and Analytical** research design.
2. **Data Sources:** Secondary data has been collected from:
 3. Reports of the 14th and 15th Finance Commissions.
 4. Reserve Bank of India (RBI) annual reports on *State Finances*.
 5. Union Budgets (2014–2025) and the Economic Survey of India.
6. **Analytical Approach:** Trend analysis of tax devolution percentages and a comparative study of state revenue autonomy before and after the GST rollout.

Key Analysis: The Decade of Reform (2014–2025)

The 14th and 15th Finance Commissions: A Quantitative Leap

1. The 14th Finance Commission (2015–2020), led by Dr. Y.V. Reddy, introduced a monumental shift by increasing the vertical devolution from **32% to 42%**. This was not merely a numerical change but a structural move to reduce "tied" grants (where the Centre dictates the spending) and increase "untied" funds, thereby respecting the fiscal autonomy of states.
2. **The 15th Finance Commission (2021–2026):** Chaired by N.K. Singh, it faced the challenge of a changing map (the reorganization of Jammu & Kashmir). It adjusted the devolution to **41%**, keeping 1% for the new Union Territories.
3. **Revised Horizontal Criteria:** The 15th FC introduced the **'Income Distance'** (45%) and **'Demographic Performance'** (12.5%) criteria. By using the 2011 Census instead of the 1971 Census, it sought to balance the needs of states with high populations against those that successfully implemented population control measures.

The GST Regime: The Era of "Pooled Sovereignty"

The implementation of the **Goods and Services Tax (GST)** in July 2017 ended the era of fiscal "separation of powers" and introduced "shared powers."

1. **Loss of State Autonomy:** States surrendered their right to levy Sales Tax, VAT, and Entry Tax—their primary sources of independent revenue.
2. **The GST Council as a Federal Floor:** The Council is a unique institutional innovation where the Union has 1/3rd voting power and States collectively have 2/3rd. No decision can be passed without a 75% majority, effectively giving states a collective veto and creating a system of **"Pooled Sovereignty."**
3. **The Compensation Mechanism:** To mitigate the risk of revenue loss, the **GST (Compensation to States) Act, 2017** guaranteed a 14% annual revenue growth for five years. The expiration of this period in June 2022 and the subsequent transition in 2023–2025 has become a focal point of state-level fiscal stress.

NITI Aayog: From Allotment to Achievement

The transition from the Planning Commission to **NITI Aayog** in 2015 marked the death of the "One-Size-Fits-All" approach.

1. **Think-Tank Approach:** Unlike its predecessor, NITI Aayog does not allocate funds; instead, it provides technical advice and fosters **Cooperative Federalism** through the Governing Council (comprising all Chief Ministers).
2. **Competitive Federalism:** By launching indices like the **Sustainable Development Goals (SDG) India Index**, **Export Preparedness Index**, and **Health Index**, NITI Aayog has forced states to compete for better governance outcomes. This "ranking culture" has incentivized states to improve their ease of doing business to attract private capital, shifting the focus from "requesting central funds" to "improving state performance."
3. **Centrally Sponsored Schemes (CSS) Rationalization**
4. A subtle but vital detail of this decade is the restructuring of CSS. Based on the recommendations of a sub-group of Chief Ministers, the funding patterns were changed (typically 60:40 for general states and 90:10 for North-Eastern/Himalayan states). This forced states to have more "skin in the game," ensuring better accountability and implementation of national priority projects at the local level.

Summary Table for the Decade

Feature	Pre-2014 Era	2014–2025 Era
Institutional Driver	Planning Commission (Top-Down)	NITI Aayog (Bottom-Up)
Tax Devolution	32% (13th FC)	41% - 42% (14th & 15th FC)
Indirect Taxation	Fragmented (VAT, Excise, Service Tax)	Unified (GST)
Federal Philosophy	Administrative Federalism	Cooperative & Competitive Federalism
Primary Grant Type	Tied/Discretionary Grants	Untied Devolution & Interest-free Loans

Findings and Challenges

The "Cess and Surcharge" Constraint: The Shrinking Divisible Pool

A critical finding of this study is the divergence between the *statutory* tax share and the *effective* tax share.

1. **The Mechanism:** While the Finance Commission mandates a 41% share of the "divisible pool," the Union government has increasingly utilized **Article 271** to levy cesses (e.g., Health and Education Cess, Krishi Kalyan Cess) and surcharges. Unlike basic excise or income tax, these collections are not shareable with the States.
2. **The Impact:** Data from 2014 to 2024 shows that cesses and surcharges as a percentage of the Centre's Gross Tax Revenue (GTR) nearly doubled, rising from approximately **10% in 2014-15 to nearly 20% in recent years**.
3. **The Result:** This trend effectively reduces the states' actual share of the total tax collected to roughly **30-32%**, creating a "fiscal bypass" that undermines the 15th Finance Commission's intent.

Vertical and Horizontal Imbalances

The research highlights a persistent "Scissor Effect" in Indian federalism:

1. **Vertical Imbalance (Functional vs. Financial):** There remains a mismatch between revenue powers and expenditure obligations. While the Union controls highly elastic revenue streams (Corporate Tax, Customs, Integrated GST), the States are the primary providers of merit goods. States currently shoulder nearly **60% of total public expenditure** and **80% of social sector spending**, yet they have limited autonomy to raise independent revenue post-GST.
2. **Horizontal Imbalance (Equity vs. Efficiency):** The devolution formula faces a "Performance Paradox." Richer, high-performing states (like Maharashtra, Karnataka, and Tamil Nadu) express concerns that the criteria for '**Income Distance**' and '**Population**' effectively tax their efficiency to subsidize states with lower developmental indices. The challenge for 2025 and beyond is to reward fiscal discipline without abandoning the constitutional goal of equitable national development.

Post-Pandemic Debt Management and the "Golden Rule" of Borrowing

The COVID-19 shock forced a temporary relaxation of the **FRBM (Fiscal Responsibility and Budget Management)** limits, allowing states to borrow up to 5% of their GSDP.

1. **Debt-to-GSDP Ratios:** In the wake of the pandemic, several states saw their debt levels exceed **30-35% of their GSDP**, raising concerns about long-term sustainability.

2. **Capital Expenditure (CAPEX) Support:** To prevent a collapse in infrastructure investment, the Union launched the "**Scheme for Special Assistance to States for Capital Investment.**" Providing **50-year interest-free loans** (totalling over ₹1.3 lakh crore in 2023-24 alone) acted as a fiscal stabilizer. However, this has also centralized control over state-level project priorities, as the loans are often tied to specific reforms (e.g., urban planning, digital infrastructure).

The "Fiscal Cliff" Post-GST Compensation

The cessation of the GST Compensation period in June 2022 marked a turning point. During 2017–2022, states were guaranteed a 14% growth in revenue. The removal of this "safety net" has exposed states with weak manufacturing bases or inefficient tax administration, leading to a widened revenue deficit in several provinces as they approach the 2025 fiscal year.

Summary of Challenges (2024-2025)

Challenge	Impact on States	Policy Requirement
Cess Proliferation	Reduced share in actual tax revenue.	Limit cesses or include them in the divisible pool.
End of GST Subsidy	Sharp drop in revenue for some states.	Enhancement of State GST (SGST) collection efficiency.
High Debt Levels	High interest payments limiting social spend.	Adherence to new FRBM glide paths.
Centralization of CAPEX	Reduced state priority in local infra.	Greater flexibility in "Special Assistance" loan terms.

Conclusion

A Decade of Fiscal Transition (2014–2025)

The period between 2014 and 2025 represents a landmark era in Indian fiscal history, characterized by a fundamental shift from a centralized "command and control" economy to a framework of **Cooperative Federalism**. The replacement of the Planning Commission with **NITI Aayog** in 2015 successfully dismantled the "one-size-fits-all" approach, replacing it with a bottom-up, consultation-based model. Furthermore, the **14th Finance Commission's** decision to increase tax devolution from 32% to 42% significantly empowered state treasuries with unconditional funds. The 15th Finance Commission continued this trajectory, maintaining a 41% share while introducing performance-based incentives for health and education. However, the 2017 rollout of the **Goods and Services Tax (GST)** introduced a unique paradigm of "pooled sovereignty," where states gained a collective vote but lost individual tax autonomy. While GST created a unified national market, the expiration of the **GST Compensation period in 2022** exposed many states to sudden revenue volatility. A significant challenge identified during this decade is the Union government's growing reliance on **cesses and surcharges**, which remain outside the shareable tax pool. This "fiscal bypass" has effectively reduced the actual revenue reaching states to levels well below the statutory 41% mandate.

Additionally, the **COVID-19 pandemic** tested the limits of federal resilience, necessitating the Centre to act as a "lender of last resort" through 50-year interest-free capital loans. While these loans stabilized infrastructure spending, they also increased central oversight over state-level project priorities. Tensions also remain regarding **horizontal equity**, as performing states feel penalized for their demographic and economic efficiency. As India moves toward a **\$5 trillion economy**, the fiscal trust deficit between the Centre and States must be bridged through transparent revenue sharing. Ultimately, the **16th Finance Commission** faces the critical task of ensuring that the "Spirit of Federalism" is not just a political slogan but is supported by the "**Certainty of Funds**" for every state. Sustained national growth will only be possible if states are treated as equal financial partners in the "Team India" vision beyond 2025.

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OriginalArticle

Women Empowerment and Sustainable Development

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Abstract

Women empowerment is a transformative process that enhances women's ability to participate fully in economic, social, and political life. It is widely recognized as a cornerstone of sustainable development, which integrates economic growth, environmental protection, and social equity. This paper explores the conceptual framework of women empowerment and its interlinkages with sustainable development. It examines key determinants, sectoral contributions, and persistent challenges while proposing policy strategies. The study finds that empowering women leads to improved development outcomes, inclusive growth, and long-term sustainability.

Keywords: Women Empowerment, Sustainable Development, Gender Equality, SDG 5 (Gender Equality), Economic Empowerment, Social Empowerment, Political Empowerment.

Introduction

Women play a crucial role in shaping societies and economies, yet gender inequality continues to limit their potential. Historically, women have faced discrimination in access to education, employment, property rights, and political participation. These inequalities hinder not only individual development but also broader societal progress. Sustainable development, as a global priority, emphasizes inclusivity and equity.

Gender equality is embedded in international frameworks such as the Sustainable Development Goals (SDGs), particularly SDG 5, which focuses on achieving gender equality and empowering all women and girls. Women empowerment is no longer viewed solely as a social justice issue; it is now recognized as a development imperative. Societies that invest in women's education, health, and economic participation tend to experience faster and more sustainable growth.

Objectives of the paper

1. Examine the concept and dimensions of women empowerment.
2. Analyze the relationship between women empowerment and sustainable development.
3. Identify key factors influencing women empowerment.
4. Explore the role of women in economic, social, and environmental sustainability.
5. Highlight major challenges and barriers.
6. Suggest policy recommendations to strengthen women empowerment for sustainable development.

Women empowerment is a multidimensional concept encompassing

Economic empowerment – access to income, employment, and financial resources. Social empowerment education, health, and social status. Political empowerment – participation in governance and decision-making. Psychological empowerment -self-confidence and agency. Empowerment involves both individual transformation and structural change. It requires dismantling systemic barriers such as patriarchy, discrimination, and unequal power relations.



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“Empowerment strengthens women to possess economic and social power enabling participation in decision-making processes.”

(Jaber & Matrood, p. 45)

The great writer, Arora says in his book as: “Development cannot be inclusive unless women share equal access to resources, opportunities, and decision-making institutions.” (Arora & Kukreja, p. 12) These perspectives highlight that empowerment is not merely about welfare but about enabling women to exercise control over their lives.

Concept of Sustainable Development

Sustainable development is defined by three core pillars

1. Economic Sustainability – continuous and inclusive economic growth
2. Social Sustainability– equity, justice, and improved quality of life
3. Environmental Sustainability – conservation of natural resources

The concept gained global prominence through the Brundtland Report (1987), which emphasized intergenerational equity. The above writer mentions as

“Sustainable development requires balancing economic progress with environmental protection and social equity.”

(Ibid, p. 5)

Gender equality is essential to all three pillars. Without women’s participation, sustainability efforts remain incomplete and ineffective. Women empowerment and sustainable development are mutually reinforcing. Empowered women contribute to development, and sustainable policies create conditions for empowerment.

Economic Linkages

Women’s participation in the workforce increases productivity and economic growth. Studies show that closing gender gaps in employment could significantly boost GDP in developing countries. Social Linkages: Educated and empowered women invest more in their families, improving health, nutrition, and education outcomes for future generations.

Environmental Linkages

Women often manage natural resources such as water, forests, and agriculture. Their involvement leads to more sustainable environmental practices. The authors wrote as

“Empowering women has a multiplier effect on productivity, economic growth, and social development outcomes.”

(Sharma & Shastri, p. 22)

Role of Women Empowerment in Sustainable Development

Women contribute significantly to both formal and informal economies. Empowerment enhances

1. Entrepreneurship and innovation
2. Financial independence
3. Poverty reduction

Microfinance initiatives and self-help groups have proven effective in improving women’s economic status, especially in developing countries like India.

Social Development

1. Higher literacy rates
2. Reduced child mortality
3. Improved healthcare outcomes
4. Gender-sensitive social policies

Educated women are more likely to educate their children, creating a cycle of development.

Political empowerment ensures women’s representation in decision-making bodies. It leads to more inclusive governance and policies addressing issues like healthcare, education, and social welfare.

Environmental Sustainability

Women play a critical role in environmental conservation. Their knowledge of local ecosystems contributes to sustainable resource management. “Women-led initiatives have significantly improved rural incomes and promoted sustainable livelihoods.” (Times of India, p. 4)



Despite progress, several barriers persist

1. Gender discrimination
2. Wage inequality
3. Limited access to education
4. Gender-based violence
5. Underrepresentation in leadership
6. Digital divide

In many societies, deeply rooted cultural norms continue to restrict women's autonomy.

Government and Policy Initiatives

Government and policy initiatives play a crucial role in advancing women empowerment and aligning it with sustainable development goals. In India, several targeted programs have been launched to improve the status of women across social, economic, and political spheres. Initiatives such as Beti Bachao Beti Padhao focus on promoting girl child education and addressing gender imbalance, while Pradhan Mantri Ujjwala Yojana enhances women's health and reduces environmental hazards by providing clean cooking fuel.

Economic empowerment is supported through schemes like Deendayal Antyodaya Yojana, which strengthens self-help groups and promotes financial inclusion among women. Additionally, legal frameworks such as Protection of Women from Domestic Violence Act safeguard women's rights and ensure protection against abuse. At the global level, organizations like the United Nations advocate gender equality through initiatives such as the Sustainable Development Goals. Together, these policies create an enabling environment for women to participate fully in development processes, thereby contributing to long-term sustainability.

Conclusion

Women empowerment is indispensable for achieving sustainable development. It enhances economic productivity, social equity, and environmental sustainability. While progress has been made, significant challenges remain. A holistic approach involving policy reforms, education, and social transformation is necessary to ensure gender equality and long-term sustainability.

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OriginalArticle

Women's Empowerment and Sustainable Development: A Special Reference to *The God of Small Things*

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Abstract

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*Women's empowerment is a foundational element of sustainable development, encompassing equality, agency, and access to resources. Despite global progress, structural inequalities rooted in patriarchy, caste, and socio-cultural norms continue to marginalize women. This paper critically examines the relationship between women's empowerment and sustainable development through *The God of Small Things*. It argues that the subjugation of women, as depicted in the novel, reflects broader systemic barriers that hinder inclusive growth. By analyzing key female characters and thematic concerns, the study demonstrates that sustainable development is unattainable without gender justice.*

Keywords Women's Empowerment, Sustainable Development, *The God of Small Things*, Gender Equality, Women's Rights, Social Justice, Human Rights.

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Introduction

The discourse on sustainable development increasingly recognizes gender equality as a central concern. Women's empowerment is not merely a social objective but a transformative force that influences economic growth, social cohesion, and environmental sustainability. Arundhati Roy, in *The God of Small Things*, offers a nuanced portrayal of gender, caste, and power in postcolonial India.

The novel reveals how deeply entrenched inequalities shape women's lives and restrict their agency. Roy famously writes, "They all crossed into forbidden territory... the laws that lay down who should be loved, and how. And how much" (Roy 33). These "Love Laws" symbolize the rigid social structures that govern relationships and reinforce gender and caste hierarchies.

Objectives of the Study

1. To critically analyze the portrayal of women in *The God of Small Things*.
2. To examine the intersection of gender, caste, and power in shaping women's experiences.
3. To explore the relationship between women's empowerment and sustainable development.
4. To evaluate the role of literature in addressing gender inequality.

Hypotheses

1. The marginalization of women in the novel reflects systemic barriers to sustainable development.
2. Women's empowerment is essential for achieving social justice and inclusive growth.
3. Patriarchal and caste-based structures reinforce gender inequality and limit agency.



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Theoretical Framework

This study draws upon feminist and postcolonial perspectives to analyze the text. Feminist theory highlights the structural inequalities that disadvantage women, while postcolonial theory examines the legacy of colonialism in shaping social hierarchies. The intersection of these frameworks provides a comprehensive understanding of gender oppression in the novel.

Representation of Women in the Novel

Ammu: Defiance and Tragedy

Ammu emerges as the central figure representing resistance against patriarchal norms. As a divorced woman, she occupies a marginal position in society. Roy writes, "Ammu had no Locusts Stand I... no position, no property" (Roy 57). This stark statement underscores the economic and social vulnerability of women who lack male protection. Ammu's relationship with Velutha challenges both caste and gender norms. However, her defiance results in severe punishment, reflecting society's intolerance toward empowered women.

Her character demonstrates that attempts at empowerment within oppressive systems often lead to marginalization rather than liberation.

Rahel: Fragmented Identity and Emotional Displacement

Rahel represents the psychological consequences of living within a repressive environment. Her fragmented identity and emotional detachment highlight the long-term impact of gender inequality. Roy observes, "Perhaps it's true that things can change in a day... a few dozen hours can affect the outcome of whole lifetimes" (Roy 210). This reflects the precariousness of women's lives and the lasting consequences of societal control.

Baby Kochamma: Internalized Oppression

Baby Kochamma embodies internalized patriarchy. Instead of challenging oppressive structures, she reinforces them. Her actions illustrate how women, conditioned by societal norms, may perpetuate inequality. This complicates the notion of empowerment, showing that liberation requires both external change and internal transformation.

Intersection of Gender and Caste

One of the most significant aspects of the novel is its exploration of the intersection between gender and caste. Ammu's relationship with Velutha, an "Untouchable," highlights the compounded nature of oppression. Roy writes, "The Love Laws... lay down who should be loved, and how." (Roy 33)

These laws not only regulate relationships but also enforce caste boundaries, making empowerment even more difficult for women. The intersectionality of gender and caste reveals that sustainable development must address multiple forms of inequality simultaneously.

Gender Inequality and Sustainable Development

Gender inequality has far-reaching implications for sustainable development. The exclusion of women from social, economic, and political spheres limits a society's potential for growth. In the novel, the marginalization of women leads to social fragmentation and injustice. Ammu's exclusion, Rahel's alienation, and Baby Kochamma's bitterness all reflect the consequences of inequality. Sustainable development requires inclusivity, participation, and equity. Without empowering women, these goals cannot be achieved.

Socio-Cultural Barriers to Empowerment

The novel identifies several barriers to women's empowerment: Women are expected to conform to predefined roles, limiting their autonomy. Lack of financial independence restricts women's choices and reinforces subordination. Women who challenge norms face ostracism and punishment. The intersection of caste and gender intensifies oppression. These barriers illustrate that empowerment requires systemic change rather than isolated efforts.

Literature as a Medium of Social Critique

Literature serves as a powerful tool for challenging societal norms and promoting change. *The God of Small Things* exposes the injustices embedded in social structures and amplifies marginalized voices. By presenting the lived experiences of women, the novel encourages readers to question existing power dynamics and advocate for equality.

Conclusion

Women's empowerment is essential for achieving sustainable development. *The God of Small Things* provides a compelling critique of gender inequality and its consequences. Through its portrayal of women's struggles, the novel highlights the need for systemic change. Empowering women is not only a matter of justice but also a prerequisite for building inclusive and sustainable societies. The analysis confirms that women's empowerment is integral to sustainable development. The novel demonstrates that inequality leads to social instability, while empowerment fosters resilience and progress.



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The hypotheses are validated through textual evidence. Patriarchal and caste-based structures restrict women's agency, and their marginalization undermines development.

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OriginalArticle

Gender Equality in Education: Challenges, Barriers, and Pathways to Inclusion

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Abstract

Gender equality in education is a fundamental human right and an essential component of sustainable development. Although significant progress has been made globally, disparities in access, retention, and quality of education persist across genders. This research paper explores the concept of gender equality in education, identifies socio-cultural, economic, and institutional barriers, and examines strategies to promote inclusive learning environments. Drawing on scholarly books, journals, and contemporary reports, the paper argues that achieving gender equality requires structural transformation in education systems, policy interventions, and societal change.

Keywords Gender Equality, Education, Inclusive Education, Educational Equity, Sustainable Developments 4 (Quality Education), SDG 5 (Gender Equality), Women's Empowerment, Educational Inclusion.

Introduction

Education plays a crucial role in shaping individuals and societies. It is widely acknowledged as a tool for empowerment and social mobility. However, gender inequality remains a persistent issue in education systems worldwide. Amartya Sen emphasizes that "the expansion of women's capabilities is central to the development process" (Sen 191). This highlights that gender equality in education is not merely a social goal but a developmental necessity. Similarly, Naila Kabeer argues that "gender inequality reflects deeper institutionalized norms and power structures" (Kabeer 5). Thus, educational inequality must be understood within broader social and cultural contexts. Despite global commitments such as Sustainable Development Goal 4 (Quality Education) and Goal 5 (Gender Equality), millions of girls continue to face barriers in accessing education. These inequalities are especially pronounced in developing countries and marginalized communities.

Objectives of the Study

1. To examine the concept and significance of gender equality in education.
2. To analyze the major barriers that hinder gender equality.
3. To evaluate the role of educational systems and policies.
4. To propose strategies for achieving inclusive and equitable education.

Concept and Importance of Gender Equality in Education

Gender equality in education refers to equal rights, responsibilities, and opportunities for individuals of all genders in accessing and benefiting from education. Malala Yousafzai states, "we realize the importance of our voices only when we are silenced" (Yousafzai 140).



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This reflects the struggles faced by girls denied education and the importance of equal opportunities. Paulo Freire asserts that “education as the practice of freedom... enables individuals to deal critically and creatively with reality” (Freire 38). Gender-equal education empowers individuals to challenge societal inequalities. Moreover, Martha Nussbaum argues that “education is a key capability that supports human dignity and agency” (Nussbaum 80). Without equal access to education, individuals cannot fully develop their potential.

Historical Perspective

Historically, education systems have been shaped by patriarchal structures that favored male participation. Women were often excluded from formal education or restricted to domestic learning. Mary Wollstonecraft argued in the 18th century that “the neglected education of my fellow-creatures is the grand source of the misery I deplore” (Wollstonecraft 12). Her work laid the foundation for advocating women’s education. Over time, feminist movements and policy reforms have contributed to increased female enrollment. However, disparities remain in terms of quality, subject choice, and career outcomes.

Barriers to Gender Equality in Education

Socio-Cultural Norms

Cultural beliefs and traditions often limit girls’ access to education. In many societies, girls are expected to prioritize domestic roles. Pierre Bourdieu explains that “social structures are reproduced through everyday practices and beliefs” (Bourdieu 172). These practices reinforce gender inequality in education.

Economic Barriers

Poverty is a major obstacle to education, especially for girls. Families with limited resources may prioritize boys’ education. Amartya Sen notes that “poverty is not just a lack of income but a deprivation of basic capabilities” (Sen 87). Education is one such capability that is often denied.

Institutional and Systemic Bias

Educational institutions may unintentionally perpetuate gender inequality through curricula, teaching practices, and policies. Michael Apple observes that “schools reproduce the cultural and economic inequalities of society” (Apple 45). Gender stereotypes in textbooks and classroom interactions can discourage girls from pursuing certain fields.

Safety and Infrastructure Issues

Lack of safe transportation, sanitation facilities, and secure school environments disproportionately affects girls’ education, particularly in rural areas. Conflicts, displacement, and policy failures further exacerbate gender disparities in education.

Impact of Gender Inequality in Education

Gender inequality in education has wide-ranging consequences:

- Lower literacy rates among women
- Limited employment opportunities
- Economic underdevelopment
- Reduced political participation

Martha Nussbaum emphasizes that “denying education undermines human dignity and equality” (Nussbaum 82). Furthermore, lack of education restricts women's participation in science, technology, and leadership roles, perpetuating inequality.

Role of Education in Empowerment

Education empowers individuals by enhancing their knowledge, skills, and confidence. bell hooks states, “education as the practice of freedom enables us to confront domination” (hooks 86). Gender-equal education allows individuals to challenge oppressive structures. Paulo Freire also emphasizes dialogue and critical thinking as essential components of transformative education.

Strategies for Achieving Gender Equality

1. Policy and Legal Frameworks

Governments must enforce laws ensuring equal access to education. UNESCO states that “gender equality in education is fundamental to achieving sustainable development” (UNESCO 14).

2. Curriculum and Pedagogical Reforms

Curricula should promote gender sensitivity and eliminate stereotypes.

3. Teacher Training and Awareness

Teachers must be trained to identify and address gender bias in classrooms.



4. Community Participation

Changing societal attitudes is essential for long-term progress.

5. Investment in Infrastructure

Providing safe and inclusive learning environments is crucial.

6. Encouraging Female Participation in STEM

Special initiatives should promote girls' participation in science and technology fields.

Conclusion

Gender equality in education is a cornerstone of social justice and sustainable development. Although progress has been made, significant challenges remain. Addressing these challenges requires coordinated efforts from governments, educators, and communities. Ensuring equal access to education for all genders is not only a moral imperative but also a pathway to economic growth, social inclusion, and global development.

Gender equality in education requires a holistic approach that addresses both structural and cultural factors. While policies and programs are essential, changing mindsets is equally important. Naila Kabeer emphasizes that empowerment involves "the ability to make strategic life choices" (Kabeer 19). Education plays a key role in enabling such choices.

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OriginalArticle

Migration in the Novels of Amitav Ghosh: A Postcolonial, Ecological, and Historical Study

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Abstract

Migration is a central and recurring motif in contemporary postcolonial literature, particularly in the fiction of Amitav Ghosh. His novels explore migration not merely as physical relocation but as a layered phenomenon shaped by colonial histories, economic systems, ecological crises, and identity transformation. This paper critically examines migration in *The Shadow Lines*, *The Hungry Tide*, and *Sea of Poppies*, focusing on how Ghosh constructs migration as a condition of modernity. Drawing upon postcolonial and ecocritical frameworks, the study argues that migration in Ghosh's narrative universe is simultaneously historical, psychological, and environmental.

Keywords Migration, Amitav Ghosh, Postcolonial Literature, Postcolonial Theory, Diaspora Studies, Ecocriticism, Colonialism, Global Capitalism, Ecological Migration.

Introduction

Migration has become one of the defining features of modern global society. In postcolonial literature, it is not only a movement of people but also a symbolic expression of displacement, trauma, and identity reconstruction. Ghosh's fiction engages deeply with these complexities by situating migration within historical events such as colonial trade, Partition, and environmental instability.

Amitav Ghosh wrote in his *The Shadow Lines*, the narrator problematizes the idea of fixed borders: "The borders between countries are not on the ground; they are in the mind." (Ghosh 45) This statement reflects the novel's central argument that migration is shaped by imagined geographies rather than physical boundaries.

Objectives

1. To analyze migration as a thematic and structural element in Ghosh's selected novels
2. To examine colonial and postcolonial dimensions of migration
3. To explore ecological displacement in Ghosh's narratives
4. To study identity formation in migrant characters
5. To connect migration with global historical and economic systems

Research Methodology

This study adopts a qualitative research approach based on textual analysis. Primary texts include *The Shadow Lines* (1988), *The Hungry Tide* (2004), and *Sea of Poppies* (2008). Theoretical frameworks include postcolonial theory, diaspora studies, and ecocriticism. Secondary sources include scholarly books and peer-reviewed journal articles.

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Postcolonial Theory

Postcolonial theory is a critical academic framework that studies the cultural, political, and psychological effects of colonialism and imperialism on formerly colonized societies. It examines how power, knowledge, identity, language, and history are shaped by colonial domination and its aftermath. The theory is widely used in literature, sociology, history, and cultural studies to analyze how colonial structures continue to influence modern societies even after political independence. Postcolonial theory explains migration as a result of colonial domination and its aftermath. Borders, identities, and nations are seen as constructed rather than natural.

Diaspora Studies

Diaspora theory focuses on displacement, memory, and belonging. Ghosh's characters often inhabit in-between spaces. Ecocriticism highlights environmental displacement caused by ecological instability, especially visible in coastal narratives.

Migration in *The Shadow Lines*

In his novel *The Shadow Lines*, migration is deeply tied to Partition, communal violence, and the construction of national borders. Characters move between India, Bangladesh, and Britain, revealing how memory shapes belonging. "We can't tell where we are bound for; only that we are going." (*The Shadow Lines*) Migration here is uncertain and fragmented, emphasizing psychological displacement. The novel suggests that migration is not just geographical movement but also a shift in perception and identity.

Migration in *Sea of Poppies*

In another *Sea of Poppies*, migration is structured by colonial capitalism and indentured labor systems. Workers from India are transported across oceans under coercive economic conditions. "The ship was a world unto itself, carrying lives that had been uprooted." (*Sea of Poppies*) Migration here becomes forced displacement, where human beings are transformed into labor commodities. The novel highlights how colonial trade networks shaped global migration routes.

Migration in *The Hungry Tide*

In *The Hungry Tide*, migration is both human and ecological. The Sundarbans region becomes a space of constant environmental instability, forcing displacement.

"The tide country is always in motion, never fixed, never still." (*The Hungry Tide*)

Here, migration is driven by natural forces such as tides, cyclones, and changing landscapes. The novel presents an ecocritical perspective where nature itself becomes an agent of displacement.

Types of Migration in Ghosh's Fiction

1 Forced Migration

Colonial rule and economic exploitation lead to involuntary movement of people, especially in *Sea of Poppies*.

2 Political Migration

Partition and national conflicts cause identity-based displacement in *The Shadow Lines*.

3 Ecological Migration

Environmental instability displaces communities in *The Hungry Tide*.

4 Psychological Migration

Characters experience internal migration through memory, trauma, and identity crises.

"People move not only by choice but by forces they cannot see." (*The Hungry Tide*)

Identity and Migration

Amitav Ghosh's novels suggest that migration reshapes identity. Migrants exist in hybrid spaces where cultural belonging is constantly negotiated. Identity is not fixed but fluid, shaped by movement across geographical and cultural borders.

Migration and Global Capitalism

Ghosh connects migration to global economic systems. Colonial trade, indentured labor, and modern globalization all contribute to forced mobility. Migration becomes a consequence of unequal economic structures. The analysis reveals that migration in Ghosh's fiction operates at multiple levels: historical, ecological, political, and psychological. His narrative strategy connects local experiences with global systems, making migration a central metaphor of modern existence.

Conclusion

Migration in the novels of Amitav Ghosh represents a complex and layered phenomenon. It is not merely physical relocation but a condition shaped by colonial history, environmental crisis, and global capitalism. Ghosh's fiction redefines migration as a continuous process that shapes identity, memory, and belonging in the modern world.



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